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Engineering News-Record

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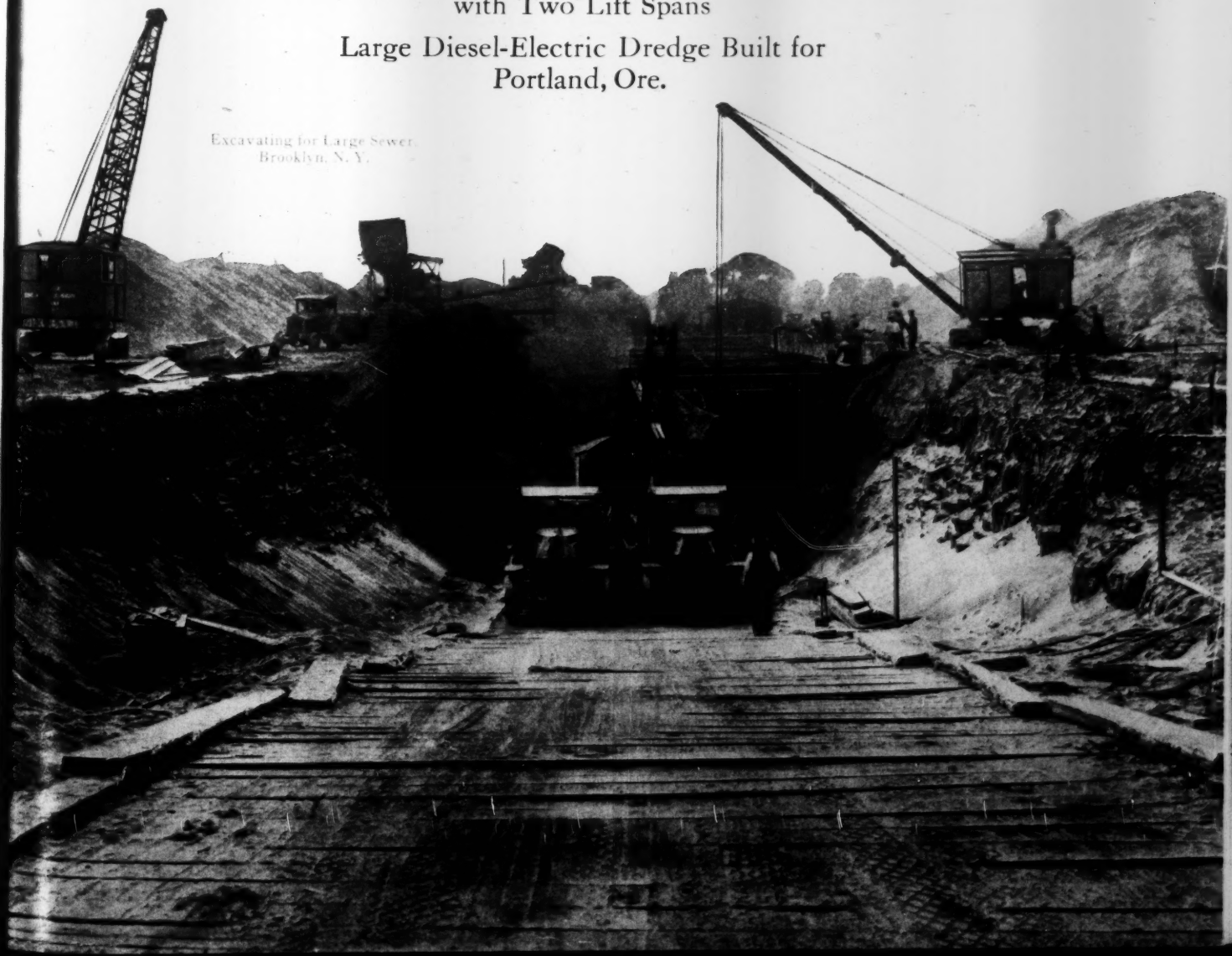
Heavy Sewer Construction Methods and Plant in Brooklyn, N. Y.

Additional Water Supply for Kansas City, Mo.

Comparison of Brick and Asphalt Pavements

Heavy Steel Work in Long Plate-Girder Bridge with Two Lift Spans

Large Diesel-Electric Dredge Built for Portland, Ore.



Excavating for Large Sewer, Brooklyn, N. Y.

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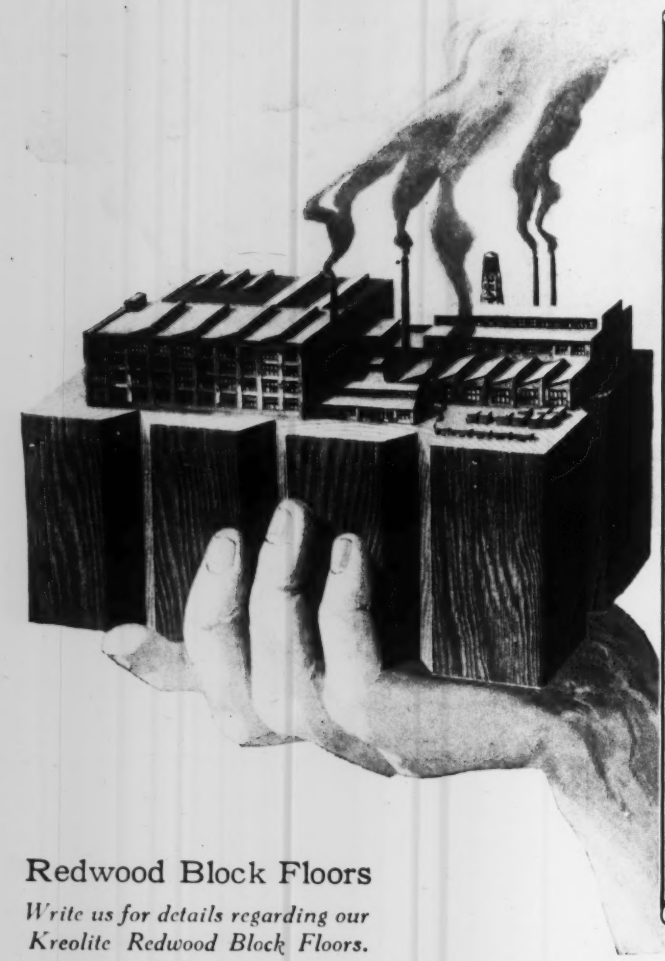

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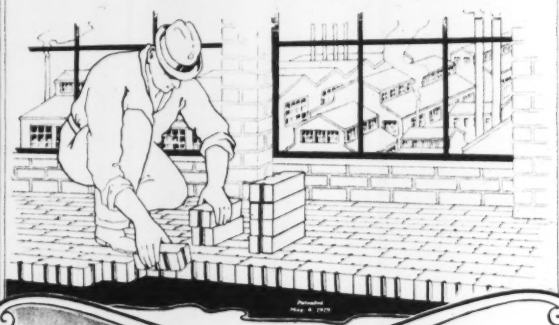

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FRANK C. WIGHT
Editor

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A Classic Example

IN THE Jersey Central bridge, whose superstructure problems are reviewed in this issue, a classic example of modern steel bridge construction is presented. Because of its great steel tonnage—surpassed in only a few of the world's bridges—economic questions assumed controlling importance, and the engineers of the work entered into them most thoroughly. The results of their studies are therefore to be accepted as a close approximation to maximum-efficiency design. When the structure is considered in this light, it must be borne in mind that not only matters of structural construction *per se* but also operating considerations were involved. The latter, for example, were largely responsible for the twin-span arrangement of the drawbridges, and for the construction of the plate-girder part of the bridge in single-track spans, grouped in twin pairs. While this feature of the bridge design was also influenced in a measure by substructure questions, the important objective of arranging the movable spans so as to make provision against interruption to either railroad or vessel traffic under all contingencies and the desirability of maintaining straight track over the entire crossing were clearly paramount considerations. There are many interesting individual phases of the superstructure design, but it may be suggested that the trend toward simplicity of structural form and makeup is particularly clear in this bridge. The lift-span design, to which our article gives much space, stands as the highest representation of modern practice in this field, and is particularly noteworthy for the special details developed to meet particular conditions of the case, among them the double sheaves and the rope-equalizing counterweights. Our review inevitably falls short of dealing with all phases of the enterprise that would interest the bridge specialist, but enough is given to permit of a fair comprehension of the problems which faced the engineers who built the structure.

Pan-American Road Work

LATIN AMERICA has definitely begun systematic highway improvement. This is the conclusion from the proceedings of the Pan-American Road Congress at Buenos Aires last summer; from the word brought back by the delegates from the United States who then visited most of the states of South America, and particularly from the reports of the Department of Commerce on public roads planned in several of the Caribbean countries. Some weeks ago we described the road plans of Salvador. They perhaps are as well thought out and as far advanced as those of any Latin American country but the plans of Mexico, Cuba, Guatemala and Panama are not far behind in development. In a word, road building has reached Central and South America, brought by the increased use of automobiles, by the mounting cost of railway construction and by, not least significantly, the interchange of visits during two years between road officials of the United States and of countries to the south. With their share in encouraging the spirit of road building which has been mentioned, the road builders of the United States have obligated themselves to render roadbuilding service to the southern nations. The first and greatest service will be to see that the new roadbuilding countries are not led into extravagances of paved and costly surfaced roads. Mileage of road is what most Central and South American countries want first—graded dirt roads and gravel and stone surfaced roads which will open up the farm land and forest and let the motor vehicle get out of the cities to the plantations. The second important service is to advise how logically to apply machinery to roadbuilding. Too often now the salesman's thought dominates the counsel given. This is not helping either roadbuilding practice or the equipment market.

Government in Business

MUCH misunderstanding exists regarding the campaign that Secretary Hoover instituted some time ago against the monopoly control of certain foreign products, notably rubber. The point at issue is well stated by Congressman Newton in his report on the crude rubber investigation: "The entry of foreign governments into the business and control of trading and the consequent rise in price at once compels consumers of such commodities to deal directly or indirectly with foreign governmental authorities and sooner or later our citizens are forced to demand that their government assist in these negotiations. This projects the government of both parties into business in large issues. As a result, the complaints of consumers of such controlled commodities throughout the world regarding real or fancied wrongs in prices, supplies, and other trading conditions become matters of governmental policy and concern and consequently stir international ill-will. In fact, through these processes, trading is being taken from the market places and encumbered with the formalities and far reaching, serious consequences of international relations with an inevitable harmful effect to the world." This is not simply a question of monopoly control, or of profiting by scarcity demand as most of the comments assume it to be. If it were only that private enterprise in this country would indeed be hypocritical in denouncing it. It is the government interference which is disturbing, with its obvious ramifications into international difficulties. And some of the critics of the Hoover campaign who have been so solicitous of the British viewpoint may be interested to know that the London *Economist*, that last word in English conservatism, has joined several other British journals in its expressed doubt of the wisdom of the rubber restriction plan under government auspices.

A Billion for Roads

HIGHWAY improvements in the United States in 1926 are estimated to cost a billion and thirty million dollars. The expenditures, as itemized by states by the Bureau of Public Roads, are given in the news columns of this issue. They are worth observing in some detail. There is not a state in the Union whose roads this year will cost less than two million dollars and in several states the cost will be from fifty to seventy-five million dollars. These are astounding expenditures. But greater significance lies in several of the other figures. About four-tenths of all expenditures will be controlled by local units smaller than the state —by county and township road commissioners. Less than one-tenth of the cost will be paid from federal-aid funds. Over two-thirds of the mileage planned for construction will be common roads—macadam, gravel and earth. Almost one-tenth of all the road mileage of the United States will be state maintained. We need to consider these facts a little attentively in the light of the common beliefs that state direction of road improvement is inclusive, that the country is running to extravagances in paved roads and curtailing common road types and that federal aid is the bulk of our road building money.

Open Reservoirs in Cities

UNCOVERED distributing reservoirs are becoming a problem to those responsible for public water supplies. Most of these are heritages from the past and many of them are so large as to make covering impracticable. Where they are still essential, any positive menace to health can generally be met by chlorinating the water as it leaves the reservoir. Fencing, regardless of the height of the fence—over which there is so much commotion just now as regards Central Park reservoir, New York City—can have no possible effect upon air-borne dust and bird droppings, which together are probably responsible for most of the adverse bacterial indications attributed to open reservoirs, whatever the real signification of these bacterial indices may be.

Cut Down Street Signal Intervals

TOO long intervals between signal shifting cause unnecessary delay in the flow of traffic. The trouble is just as apt to exist with the automatic signal where control is invariable within fixed periods of time as it is where the single policeman exercises his own judgment. Time intervals for signaling are fixed by the extent of traffic. The policeman allows traffic to run in one direction as long as there is a fair supply there or until the cross traffic piles up to the point of congestion, and the automatic signal is planned on the same theory. In consequence, any one vehicle in the cross-traffic stream, subject to possible stops at a number of intersections, accumulates in a through trip a total delay equal almost to the sum of the individual signal intervals. The cutting down of these intervals, therefore, obviously reduces the total time loss in any through trip, even though the proportion of opposing intervals continue to be in accordance with relative traffic. The evil is most pronounced in New York where the authorities, to care for the greater north and south traffic, allow that traffic so long intervals of free passage that crosstown travel is merely a succession of 3 to 5-min. stops at the avenues. In downtown Chicago, where there is more even distribution of traffic, they order the system much better. There the shifts of signals are rapid and neither pedestrian nor motor has to wait long to make way across a number of intersections. A cutting in two of the New York interval in both directions would afford much easier access crosstown by increasing the chances of reaching the north and south avenue in an open period and would not slow up the avenue traffic.

Short-Sighted Economy

ATTEMPTS to control public expenditures are too often rough handed and result in ultimate waste rather than economy. This is notably true of some of the boards that have been created in recent years to curtail expenditures for printing annual reports. The need of some curb on the size of these public documents is conceded but it should be applied with intelligent discrimination. This is particularly true of technical data, ruthlessly excluded from altogether too many annual reports of late. Only a day apart, an engineer of an important city water department and an engineer of a large water district, voiced their grievances to the writer of this note, each without knowledge of the other. The first said that pressure was brought to bear upon him to confine his reports to brief statements of the year's routine. The second bewailed the recent exclusion from the annual reports of his department of rainfall and runoff data which for decades past have been eagerly welcomed throughout the world. He is embarrassed by not being able to reciprocate in kind and degree when he receives reports from Australia with an abundance of technical data and handsome illustrations. Embarrassment is the least of the ills flowing from such false economy. It is by the exchange of data that technical progress is made, and the exchange is more extended and costs less money by way of a printed report than by private correspondence.

Modern Shepherds and Kings

LONG ages of human progress find reflection in the efforts under way to bring about the development of the irrigation and power possibilities of the River Jordan. Final grant of a concession for the undertaking by the British High Commissioner was reported last week, the development presumably to be in accordance with the project outlined by its originator, Pinhas Rutenberg, in *Engineering News-Record* of June 22, 1922, p. 1042. Successful execution of the project will recreate the land of Palestine, but it will not be the land of shepherds and kings of which there was much writing long ago. Men have changed; they have sought out many inventions.

At the dawn of history the value of water lay in its use for irrigation, which enabled great populations to grow up and become nations, builders of monuments and developers of the arts. So it remained through the centuries, up to recent times. The rise of transportation in the nineteenth century and of power in the twentieth has changed things fundamentally.

Today the irrigation value of water in any region is limited by competition. Rail and road and steamship are ready to bring in the produce of more favored lands at low cost, and the local agriculture cannot survive if it is unable to meet the competitive price. Thus a limit is set to what the farmer can pay to build irrigation works. In spite of vastly increased efficiency of con-

struction in this era of engineering, irrigation developments may nevertheless be unprofitable today that were richly productive in the remote past.

In the meantime a new factor has been created in the power value of water. Now that it is possible to make the energy of the falling cataract available in protean form in every house of the countryside and to utilize this energy in countless forms for industrial production, the growth of a region retains only a slender connection with its agriculture. Yet that connection, however slender, remains in existence. Irrigation and agriculture are still vital.

So the modern system of combined power and irrigation development comes naturally into being. In its most typical form, and this is its form in the case of the Jordan, power is the primary objective of development, while irrigation is an important—and it may be a vital—byproduct. So it is also in the great development proposed on the Colorado River. They stand and fall together, however. Irrigation could not come about if it were not that power pays most of the cost. And power, while it possibly could exist alone, would never fully flourish were the irrigation not also developed, to make the land fruitful and pleasant.

In the new Palestine, the land of industry and power—if the hopes of its friends come true—there will still be shepherds and tillers of the soil. If there be kings, they will be kings of the factory and workshop; yet their power too will have its source in the Jordan waters, as did the power of those who were kings when the land was young.

Standard Cement on the Defensive

IN THE great growth of the standard specification for the purchase of material which has been one of the features of the past quarter century of engineering development no standard has had wider use than the specification for portland cement. It has been adopted by most of the societies whose members buy cement, it has been stamped with that hallmark of approval, "American Standard," by the American Engineering Standards Committee and it has been made the cornerstone of the selling policy of the manufacturers of cement. In general acceptance no cement is a portland unless it passes that specification, and any cement that passes it is as good as any other.

And yet for a number of years that specification has been the subject of attack, sporadic to be sure and frequently none too well backed with knowledge, but indicative of a dissatisfaction among users. That these attacks have not brought about any but minor changes is due as much to the inability of the critical user to submit valid argument for change as it is to the concerted effort of the manufacturers in resistance of such change. The user, as a unit, does not know what change he wants. The producer, while probably sympathetic to any change that will bring better cement, is dubious of the suggested improvements and anxious, for quite valid economic reasons, to retain the *status quo*. As an earnest of their desire for an improved material, however, the manufacturers have financed a costly investigation into cement at the Bureau of Standards and suggest, at least tacitly, that changes in the specification be withheld until that investigation accumulates enough facts on which revision can proceed scientifically.

Meanwhile, an attack on the standard specification has come from a new quarter. By agreement, or by common acceptance of a theory, several of the larger state highway departments have discarded the standard specification to the extent of requiring higher tensile mortar tests. Instead of 200 lb. at 7 days and 300 at 28 days, an additional 25 or 50 lb. is asked for each test. And in one state, at least, the major cement companies have refused to bid on a large contract under such specifications, not on the ground that they cannot furnish such cement but because to offer to furnish it would violate the fundamental principle of a standard cement on which the whole theory of cement merchandising is based. If the higher standard idea spreads among the highway departments, as it promises to do, it will be quite readily seen that one of several things will happen: either the big companies will lose business, the standard specification will go by the board or be changed or the highway departments will have to back down for lack of adequate competition.

Which alternative will occur cannot be predicted, but in any event the revolt marks a definite stage in the cement standard development. It is the first sign of a concerted and authoritative refusal to accept the standard as sacred or to defer action until more knowledge is available. It puts squarely up to the cement committee of the American Society for Testing Materials, the sponsor of the cement standard, the necessity for immediate action either for or against the change.

It is not that the change is so important. Indeed, the highway departments would seem to have taken a weak cause on which to base a revolution. The difference of 25 lb. in a cement briquette test is a rather flimsy reason for the acceptance or rejection of a cement, when one realizes how variable are the results of the standard break tests. Conceivably, if one knew absolutely that a given cement had a tensile strength consistently 12½ per cent higher than another one might prefer that cement, though when the difference is between 200 and 225 lb. at 7 days even that is doubtful, so tenuous is the proved relation between tensile tests and concrete behavior. But when half a hundred accepted laboratories, using standard tests, report the same cement with 300 per cent variation in strength, as they have done, to assign much importance to tensile tests is questionable.

But at that most of the cement companies could furnish the cement under one test as well as the other. And the consumer should be entitled to get what he wants, when certain of the producers are willing to furnish it. So it is a principle that is in question now and that principle must be fought out soon in committee C-1 of the American Society for Testing Materials. Is the committee to stick to the policy that all present perfection of knowledge is lodged in the standard specification and by so doing throw open the door to the old days of every user for himself as to specification; or is it, failing to persuade the revolutionists, to make such concessions as will satisfy them and retain the single standard idea?

In any case the old question rises: How much longer will the theory persist that all cements that pass a standard (which like all standards paradoxically seems to be variable) are equal in quality and therefore worth the same price, no matter how great is their variation beyond the passing requirements? The action of the highway departments emphasizes the query.

Heavy Steelwork in Long Plate-Girder Bridge With Two Twin Lift Spans

More Than Three Hundred Main Girders Required—288 Duplicate 54-Ton Girders — Rocker Expansion Bearings — Lift Spans Have Double Sheaves and Rope Equalization by Auxiliary Counterweights

(With 3-page insert)

QUITE unusual problems of steel bridge construction confronted the engineers who built the new crossing of the Central R.R. of New Jersey over Newark Bay, just completed. Because of the great length of the bridge, 7,411 ft., and the four-track width, as well as the required span arrangement, the total volume of work was so great as to call for extreme study of economy in both design and execution. The fixed plate girder spans of the bridge alone included nearly 20,000 tons of steelwork, distributed among 41 plate girder spans, involving 164 separate single-track spans, most of them 125 ft. long. This part of the work included 288 girders identically alike, so that a very few pounds more or less per individual girder meant an excess or saving of tons. In addition, four double-track movable spans had to be built, of 216½ and 305 ft. length, respectively, whose service was subject to such exacting railroad and water traffic conditions as to make severe demands on speed and reliability of operation.

An account of the problems of general planning and of substructure work has already been given (*Engineering News-Record*, Feb. 4, p. 184). The engineering work involved in the superstructure is discussed in the present article.

General Superstructure Plan—The minimum span length for the fixed bridge, constituting the major part of the crossing, was specified by the War Department as 125 ft. center to center of pier, though subsoil conditions and the resulting cost of the foundations were favorable enough to make a shorter span length economical. The 125-ft. span was departed from only landward of the pierhead lines and immediately adjacent to the channel spans.

Vertical underclearance was controlling only at the draw (35 ft.), while in the fixed spans as much height as was desired could be used for the structure, so that deck construction was permissible here. The span length was suitable for plate girders, but comparative designs were made for deck trusses, as well as for a variety of plate-girder arrangements, including continuous spans, successions of cantilever and suspended spans, and simple spans. The comparisons covered silicon steel and nickel steel as well as ordinary structural steel. The figures showed that simple spans of plate girders, built of structural steel, were most economical, and they were adopted. Since the cost differential of silicon steel represented a less expense than a gain resulting from the higher unit stresses, it might appear that this material should have proved cheapest for the girders; however, the web metal turned the result in favor of the carbon steel design.

Plate Girder Design—The girders as well as the movable spans were proportioned for Cooper's E60 loading, using the regular unit stresses of the American Railway Engineering Association bridge specifications (16,000 lb. basic). The possibility of heavier traffic at a future time was thought to be sufficiently provided for by these conservative unit stresses. Impact was calculated according to the older A. R. E. A. formula, namely $\frac{300}{300 + L}$ in place of the formula of the 1920 specification.

A simple I-shaped cross-section (Fig. 5) was worked out for the main girders, but only by exceeding the 50 per cent cover-plate ratio formerly used. The flanges, using two 8x8x⅞-in. angles, were proportioned by calculations of limiting horizontal shear, at 4,000 lb. per sq.in. in the flange-angle sections, under the 1920 A. R. E. A. specification. The inner cover plate does not extend full length on either flange, but the top flange has a thin cover-plate over the angles beyond the inner plate.

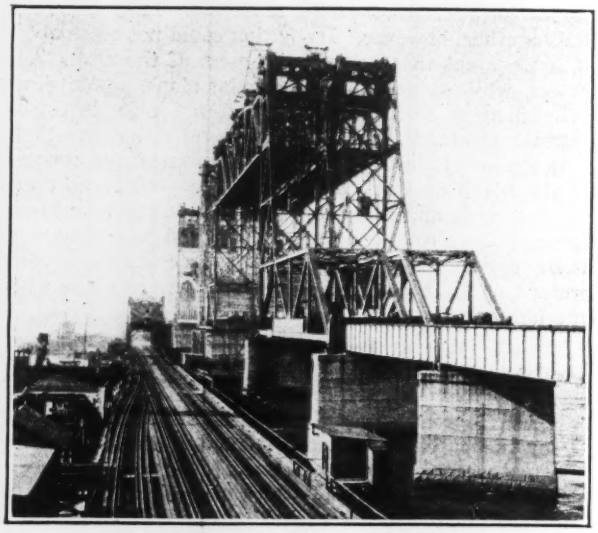


FIG. 1—OLD AND NEW BRIDGES OVER NEWARK BAY, CENTRAL R.R. OF NEW JERSEY

At left, old timber trestle bridge with two double-track bascule bridges. At right, new four-track steel plate-girder bridge with two twin vertical lift spans.

The girders were spaced 8 ft., in view of the length and the height of girders. The bottom and top lateral systems were so arranged as to make each span reversible, by the introduction of two half panels at midspan with diagonals arranged to form a zigzag. As a result, all girders are alike, except that the inner pair of each double-track set of four girders has top flange holes for the connection of occasional struts which tie the two inner single-track bridges together. However, all the outer girders are interchangeable among themselves or end for end, and the same is true of the inner girders.

Camber (½ in.) was provided for dead-load only. The ties (12 in. depth at midspan) were varied in depth to make up the flange plate offset, but were not dapped for camber. They were notched to fit over the cover plates and slotted to fit over the rivet lines, before creosoting, so that there was no work required on them in the field.

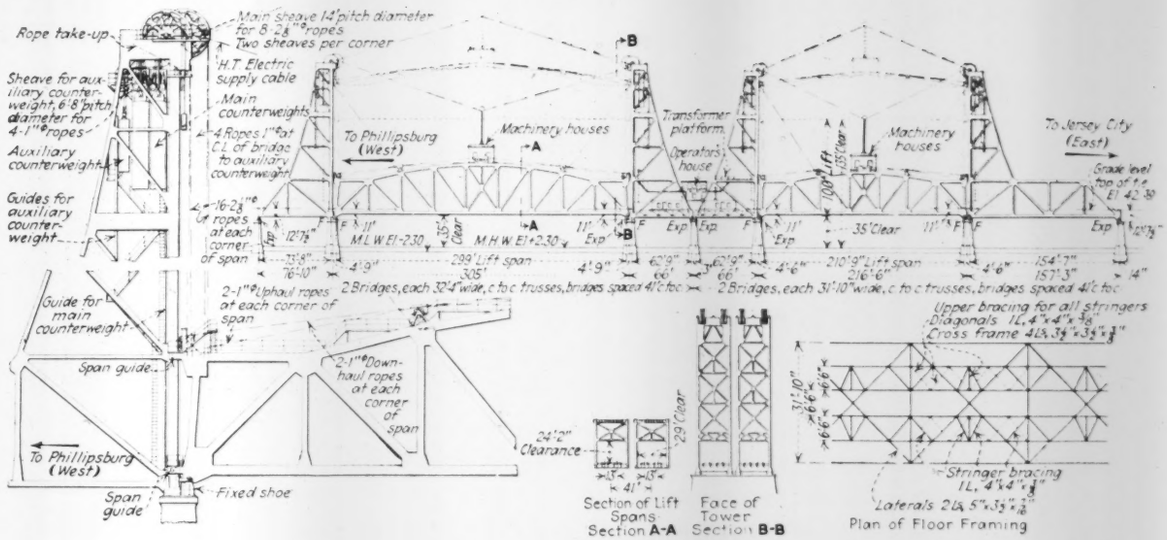
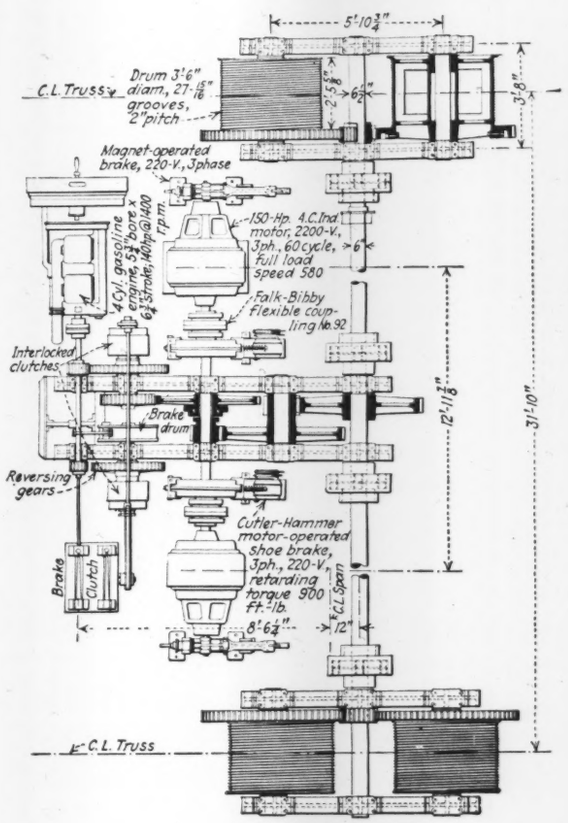

Rope take-up
Main sheave 14' pitch diameter for 8-2⅛" ropes
Two sheaves per corner
H.T. Electric supply cable
Main counterweights
4 Ropes 1" ø at C.L. of bridge to auxiliary counterweight
Sheave for auxiliary counterweight, 6'8" pitch diameter for 4-1" ø ropes
Auxiliary counterweight
Guides for auxiliary counterweight
16-2⅜" ø ropes at each corner of span
2-1" ø Uphaul ropes at each corner of span
Guide for main counterweight
Span guide
2-1" ø Downhaul ropes at each corner of span
To Phillipsburg (West)
Span guide
Fixed shoe
To Phillipsburg (West)
Machinery houses
Transformer platform
Operator's house
Machinery houses
To Jersey City (East)
Grade level top of rail El. 42.38
M.L.W. El-2.30
M.H.W. El+2.30
35' Clear
100' Lift
2 Bridges, each 32'4" wide, c to c trusses, bridges spaced 41' c to c
305'
299' Lift span
2 Bridges, each 31'10" wide, c to c trusses, bridges spaced 41' c to c
216'6"
210'9" Lift span
157'3"
24'2" Clearance
29' Clear
Section of Lift Spans Section A-A
Face of Tower Section B-B
Upper bracing for all stringers
Diagonals 1L, 4"x4"x⅝"
Cross frame 4 L's, 3½"x3½"x⅜"
Stringer bracing 1L, 4"x4"x⅜"
Laterals 2 L's, 5"x3½"x⅞"
Plan of Floor Framing

Fig. 8—Two Twin Lift Spans, with Rope Equalization by Auxiliary Counterweights

The 2,300-volt operating current is carried to the machinery house on top of the span by a cable led from the tower top to a rocker arm at midspan.



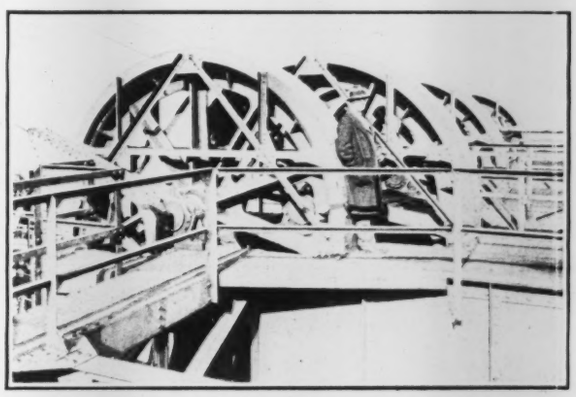


Fig. 10—Cast Steel Counterweight Sheaves on Tower, Ready for Operation

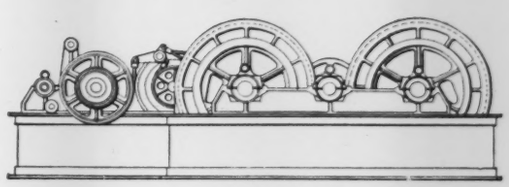


Fig. 9—Plan of Electric Operating Machinery with Gasoline Engine Auxiliary

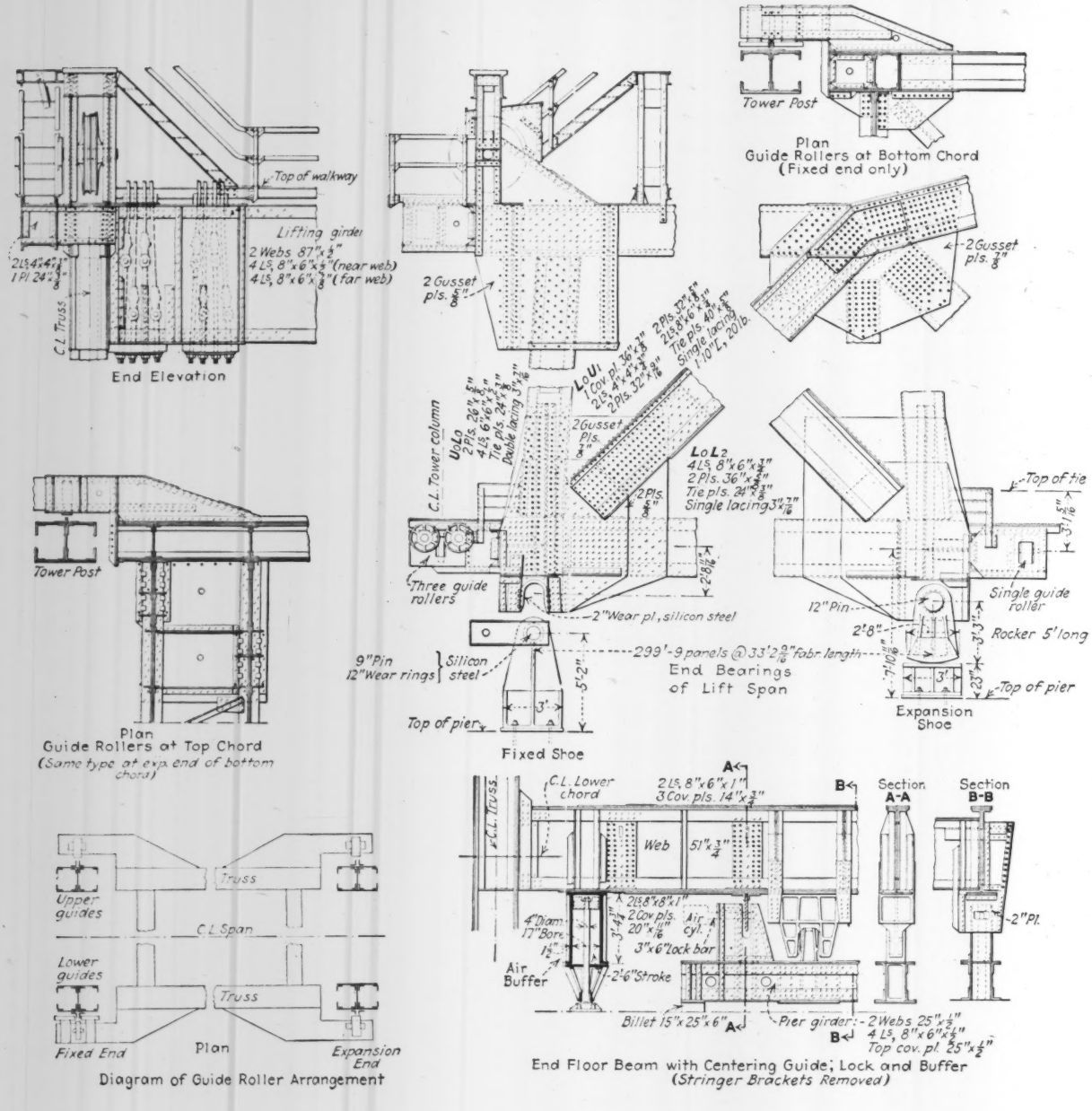
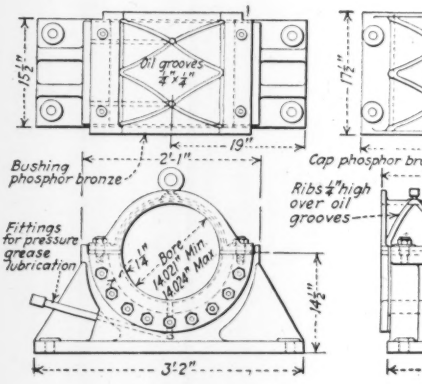


Fig. 11—Mechanical Details of Lift Spans



Details of Twin Lift Spans of Newark Bay Bridge of Central R.R. of New Jersey

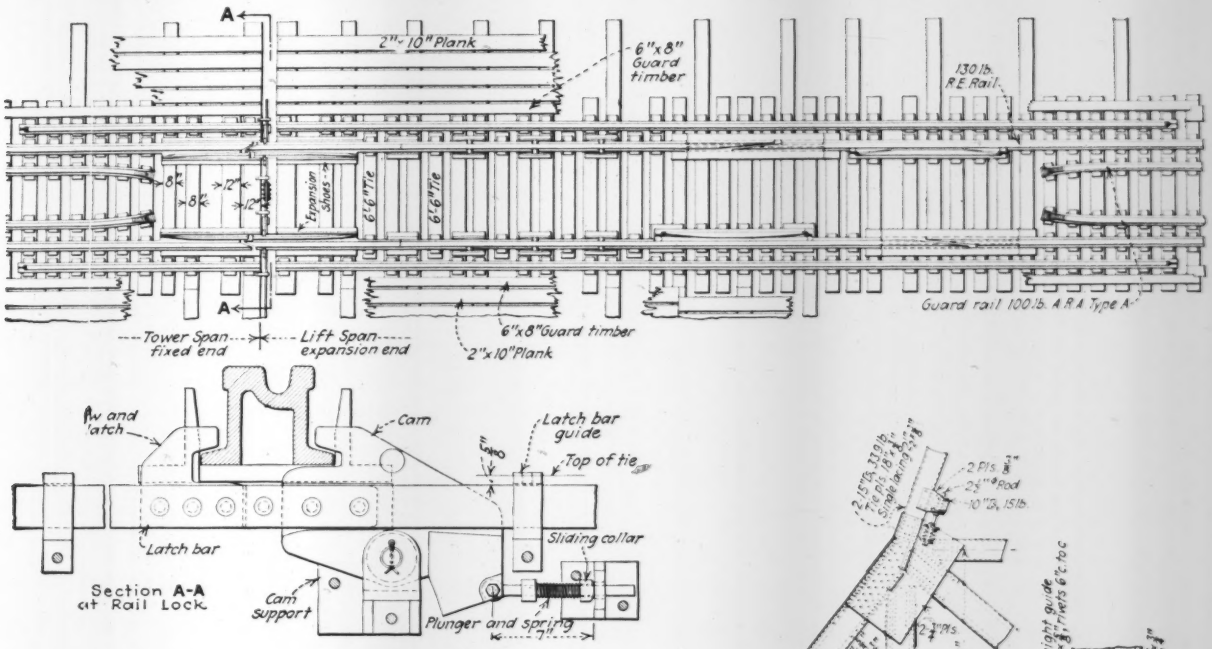


Fig. 13—Rail Joint and Guard Rails At Ends of Lift Span

The arrangement shown is for the expansion end of the span; at the fixed end the expansion joints are omitted.

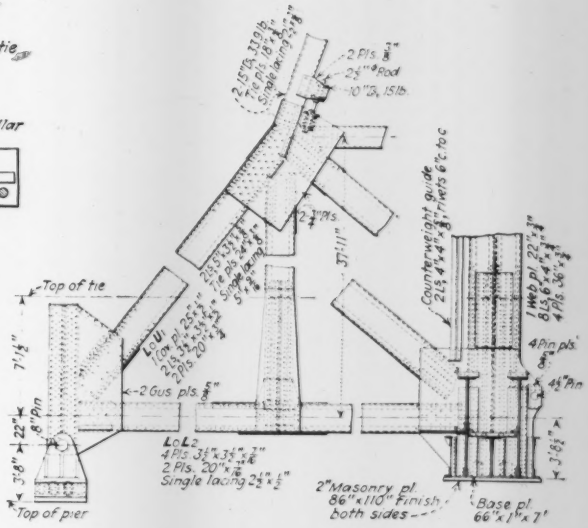


Fig. 14—Lower Part of West Tower

A screw connection is provided in the back leg for initial adjustment.

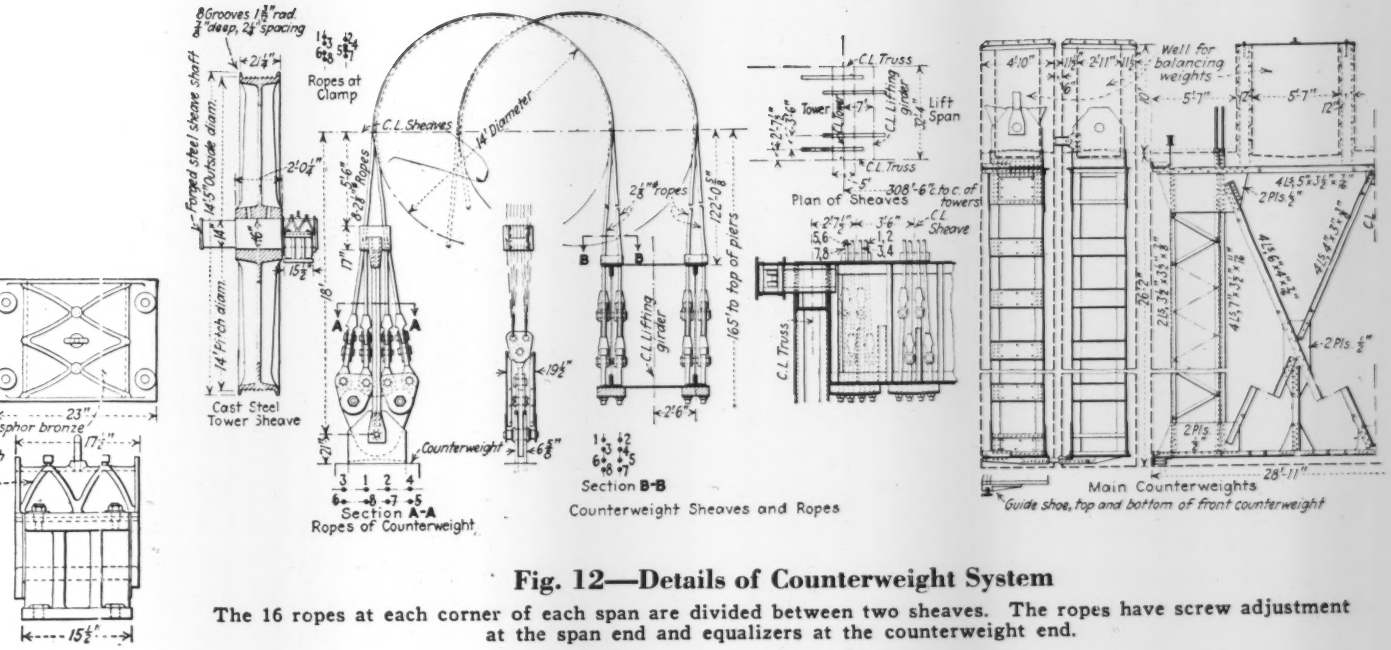


Fig. 12—Details of Counterweight System

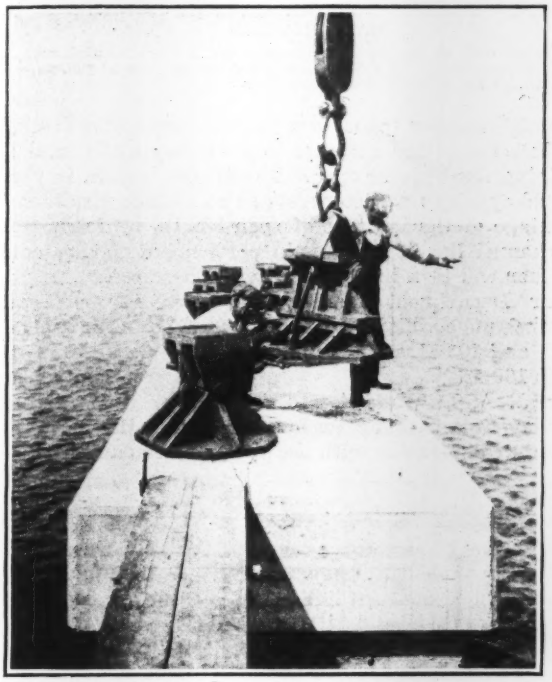
The 16 ropes at each corner of each span are divided between two sheaves. The ropes have screw adjustment at the span end and equalizers at the counterweight end.

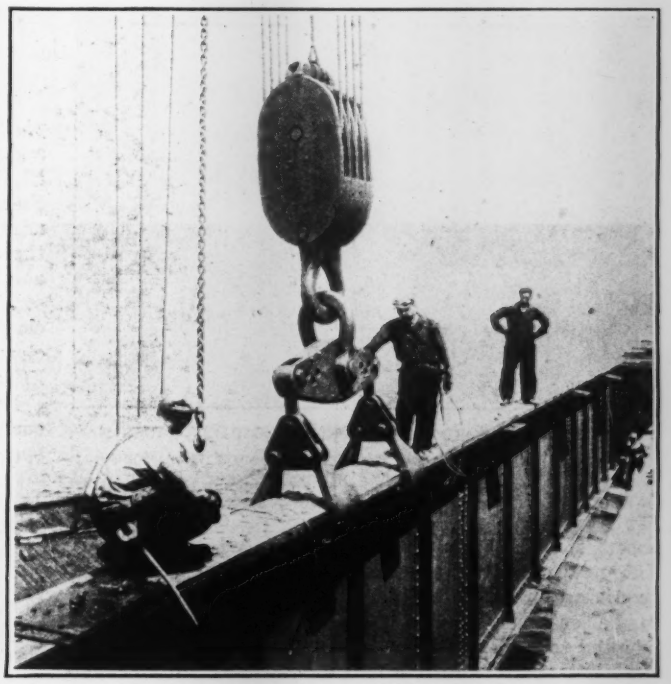
In the design of the lateral systems, 6x4-in. single angles were used, so as to permit making the connection by rivets in one leg. The lateral plates were simplified in shape as much as possible, to make it possible to cut them from a long bar with a single shearing, as sketched for one typical plate in Fig. 5.

End Bearings—At the ends the girders are arranged with a 15-in. overhang beyond center line of bearing, making the center-to-center span length 122 ft. after allowing for 6-in. clearance between ends of girders of successive spans. It was desired to use bearings of the pin type at both ends, and at the same time to avoid the use of rollers or ordinary segmental rockers, which often become ineffective from dirt accumulation, rusting or skewing. For these reasons a single-rocker type of expansion shoe was worked out, as shown by detailed drawing in Fig. 6. Upper and lower castings of the fixed-end shoe bear on a pin, turned with projecting shoulders at each end to hold it in place. At the expansion end, the pin between upper shoe and rocker has screw ends fitted with chambered or Lomas nuts which engage projecting hubs on the two castings and lock them together. For erection purposes, both bearings were provided with temporary connection of upper and lower shoe—in the fixed bearing bolts through overlapping lugs on the castings, in the expansion shoe temporary struts connecting lower and upper shoe castings. Each bearing then could be set as a single erection piece, and later the girder set on it without further support or complication.

The piles under the piers are loaded to 17 tons maximum average dead- and live-load, excluding traction, or to 30 tons per pile at the toe under maximum braking force (taken at 15 per cent of live-load for one track, or 13½ per cent for two tracks, as the commonly used 20 per cent was found to be unnecessarily high). No allowance was made for soil bearing between the piles as experience with the railroad company's other bridges in the Newark Bay area shows the soil to be so compressible as to make it inadmissible to consider soil bearing and pile bearing to act simultaneously.

To bed the girder bearings, the pier tops were axed off level to a straight-edge and the seat rubbed with a neat cement wash to fill granular inequalities. The shoes, whose bearing faces are planed, were seated directly on the surface so prepared. In the railroad company's experience it is inadvisable to attempt to bed a shoe either on cement or on lead, in view of the unsuitable character of the former and the spreading tendency introduced by the latter. It has also been found inadvisable to embed grillage beams, because of the difficulty of assuring that the bearing material under such grillages will be solid and in contact with the metal. This was the reason for detailing the pier tops of this bridge as plain concrete surfaces with ample two-way reinforcement 12 in. below the bearing surface to resist all transverse tensions. Each bearing is held in place by four anchor bolts, seated in holes drilled 10 in. deep and swedged and grouted in place.





FIGS. 2 AND 3—SETTING ROCKER SHOE FOR ONE OF THE FIXED SPANS, AND SETTING A MAIN GIRDER

In left-hand view, the fixed shoe is held together by temporary bolts. The rocker shoe is held by temporary stay bars bolted to the upper and lower shoes; upper casting and rocker locked by Lomas nuts on pin engaging projections on castings.

Other Features—Of other features of the girder construction the following points may be noted: The design contains no special provision for loss of section by rusting, in spite of the location of the structure over salt water; the assumed loading and careful maintenance are expected to make any such provision unnecessary. A single rivet size (1 in.) was used throughout. The longest practicable web plate was used, and the web splices were simplified to straight vertical splice plates. Angle splices are symmetrical, although the angle on only one side is broken at any one point; the splice angles are lighter in section than the flange angles. Cover-plate splices were made by extending

the cover plate next above. End stiffeners were required to be milled at both ends. Intermediate stiffeners are crimped. The rocker shoes, though designed originally to have the rocking face a circle with center at the pin center, were subsequently modified by shifting the center of the turned surface about 3 in. above pin center, which permitted four rockers to be assembled for machining and turned simultaneously.

Each of the 125-ft. girders weighs 108,140 lb., without shoes. The steelwork of an entire span, four tracks, with laterals and shoes but without ties and track, weighs 928,100 lb.

Type of Drawspan—In the old trestle bridge of the railroad, directly alongside the new crossing, the two channel openings are spanned by 120-ft. rolling-lift

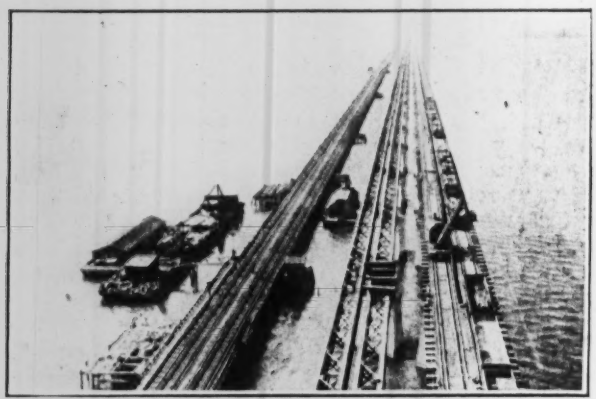


FIG. 4—WEST HALF OF THE PLATE-GIRDER BRIDGE

The fixed part of the new crossing consists of four single-track bridges carried on two independent lines of piers. Tie laying is beginning on the two eastbound bridges, at left; track is complete on westbound bridges, at right.

bascules, which twenty years ago replaced a swing span. The new crossing presented more difficult conditions, requiring spans of 216½ and 305 ft. respectively, each to be crossed by two parallel double-track bridges adapted to either joint or independent operation. Vertical lift spans were chosen as the most suitable and cheapest, showing a marked cost saving particularly on the longer span. A bascule, if of single-leaf type, would have been of unprecedented length, and double-leaf construction was not believed suitable for dense-traffic high-speed railroad requirements. A swing bridge, of course, was impracticable because of the required size and the location near the old bridge.

Twin construction—using two separate double-track bridges for each of the two channel crossings—was decided upon as most advantageous because of the thoroughgoing assurance it gives against operating derangement. It provides in very flexible manner for all contingencies, as regards rail as well as water traffic. A four-track span (with three trusses) would have been slightly cheaper than two double-track spans, but the difference was too small to influence the selection and the design was objectionable.

Square end spans were decided upon, although the channels cross the railroad line on a 59 deg. 11 min. skew and the piers of all the fixed spans are laid out on this skew. The operating advantage of square ends was considered to outweigh the cost of lengthening the spans as required for the square construction beside giving a far better channel approach. Accordingly, the main piers of the lift spans as well as the rear

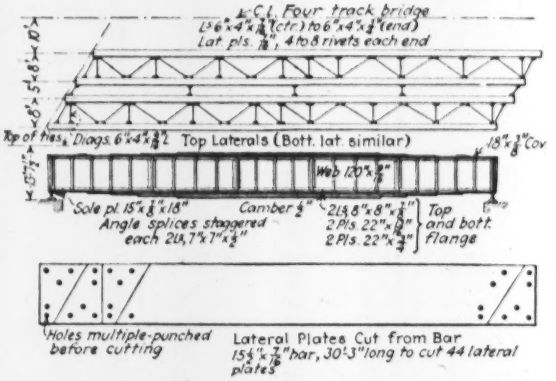


FIG. 5—TYPICAL PLATE GIRDER SPAN OF NEWARK BAY CROSSING

Lateral system arranged for symmetry, to make girders reversible; fixed and single-rocker end shoes; lateral plates arranged for cutting from long bar.

piers of the tower spans were built square to the track, and the change from square to skew was made in the adjoining fixed girder span. The fender system in the channel openings was so arranged as to take maximum advantage of the increase of span length, by following the channel lines in the main portion but flaring out at either end to a line parallel with the piers.

War Department requirements fixed the vertical clearance under the movable spans at 35 ft. with bridge closed and 135 ft. with bridge open, thus fixing the net lift at 100 ft.

Dr. J. A. L. Waddell was retained by the railroad company as consulting engineer to design the movable spans in co-operation with the railroad company's engi-

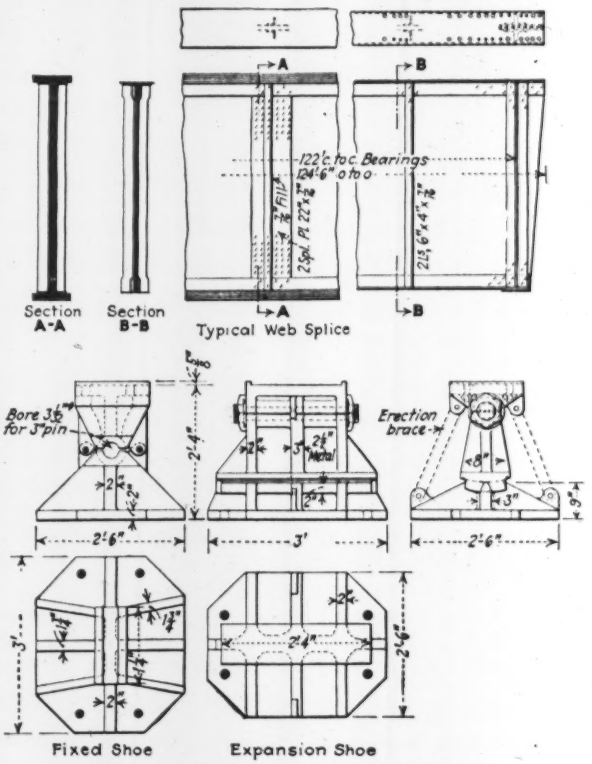


FIG. 6—PLATE GIRDER CONCTRUCTION

These girders were worked out for maximum economy in duplicate construction, as 288 girders identically alike had to be built.

neers. Shortridge Hardesty was in charge of the design and supervision of the work for Dr. Waddell.

Special Features of Lift Spans—While the general arrangement of the lift spans and the principal details follow previously established practice, several important departures were made. The problem of equalizing the shifting weight of the counterweight ropes was solved by a newly devised system, the use of auxiliary counterweights attached to the span in such a way that their lifting effect decreases as the span rises. Current supply to the operating machinery on the spans was arranged by direct cable connection, in place of sliding contact shoes as customary, mainly because 2,300-volt operating current was decided upon, this in turn being adopted because of the length of the power line and the desirability of avoiding a sub-station on the bridge, which would have been necessary if 220/440-volt current were used. Difficulties frequently encountered in the construction of the large counterweight sheaves were obviated by the expedient of using two sheaves at each corner of each span, passing eight of the sixteen ropes at each corner over one sheave. To permit close spacing of the sheaves this required a staggered arrangement which will be seen in the drawing. By this modification the sheaves, which are steel castings, became much simpler, axle loads and journal diameters were decreased, and operating friction was reduced. Pneumatic buffers, one-man control of all four spans, complete interlocking of the bridge machinery with the railroad signals and switches, remote control of the operating machinery by 220-volt control circuits, and use of electro-pneumatically operated oil switches in place of solenoid operated switches are among the other noteworthy features of the installation.

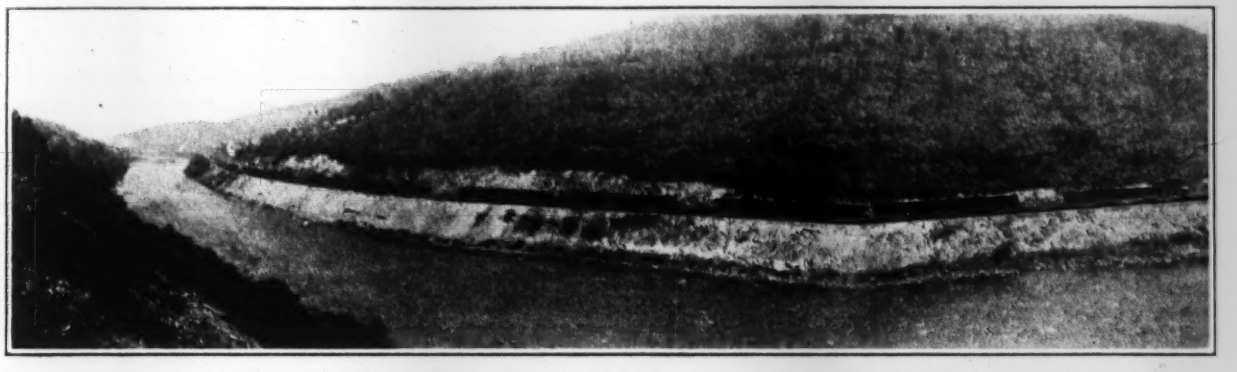


FIG. 7—SPECIAL GIRDER TRAIN ON WAY FROM SHOP TO BRIDGE SITE

Lift-Span Design—As the two lift spans are close together, being separated only 132 ft. between pier centers, it was possible to use a single tower for the two bridges between the two spans or to use two separate towers, and in the latter case to support them either on a steel span or directly on main and intermediate piers. The latter arrangement was adopted, mainly with regard to greater operating safety, wholly independent towers being considered to give more complete assurance against derangement of one span affecting the span over the other channel. This arrangement also favored the good appearance of the resulting structure, since it was possible to design the four towers to the same outline above first-story level—the lower story being varied to suit the supports.

Prior to selecting the grade of steel to be used for the spans, comparative designs and estimates were made for several grades, to determine maximum economy. For the floorbeams of the lift span, silicon steel was early decided upon, since with the restricted height between the grade line and the clearance line a carbon-steel floorbeam would require undesirably heavy sections. With respect to the trusses, designs were made for nickel steel, silicon steel, and ordinary structural steel, at working stresses of 27,000, 24,000, and 16,000 lb. per sq.in. respectively. Even at 1½c. extra cost of silicon steel over ordinary steel, the former material gave the cheapest design, and at the prices finally secured, which showed an extra cost of less than 1c., the saving was material. The nickel-steel figure was above that for silicon steel, and the large quantity of material required made its availability somewhat doubtful. Silicon steel was adopted. Stringers were built of carbon steel, but laterals and portals are of silicon steel, the laterals largely with regard to the chord participation stresses, though towers and tower spans complete are of carbon steel.

The structural design of the spans is substantial but in no particular respect unusual. The chords are two-web sections, the upper chord with top cover plate only but with bottom flange angles of large size to bring down the neutral axis. The bottom chord and the web members are made with two ribs latticed and flange angles turned in. The design is almost identical with that for a fixed span, with the addition of hanger members over each end pin, and a heavy lifting girder connecting them at top-chord level. This end frame is called upon only for hanger service, however, the top lateral stresses being taken down to the end pins through portals in the planes of the diagonal end posts. A fixed bearing is provided at one end and a large single-rocker bearing at the other end, as may be seen in Fig. 11. At the fixed end, the shoe remains seated on the pier together with its pin, which is engaged by half pin holes in the end gusset plates as the span comes down.

Roller guides are used for the lift span rather than sliding shoes as sometimes employed. The guides are pairs of angles set back to back on the side of a tower post, facing away from center line of track. At the fixed end of the span these guides are engaged by a set of three rollers mounted in a housing carried by a bracket projecting from the end of the lower chord. At the expansion end, similar brackets carry only a single roller, whose axis is longitudinal to the bridge and which bears against the edge of the outstanding

guide angles, thus guiding the span laterally. At all four corners of the top chord similar single-roller guides are provided. In all cases the single rollers are of wide face, to allow for expansion, while the rollers of the three-roller group at the fixed end of the bottom chord are narrow. The arrangement is shown in diagram and in detail construction in Fig. 11.

The counterweight rope arrangement, the division of the 16 ropes at each corner into two groups of 8 going to the two sheaves, and the end details of the ropes are shown in Fig. 12. The points of attachment to the lifting girder are in all cases directly below the counterweight sheaves on the tower tops. Screw ends at the connection of the ropes to the hanger girders provide for adjustment of length, the nuts being locked by a gang lock when adjusted. At the counterweight end compound equalizers of the construction shown in Fig. 12 are used. The counterweight frame and guide system is also indicated in Fig. 12. It will be noticed that two counterweights—one each for forward and rear pairs of sheaves in one tower—are linked together by light struts or spacers, and only the forward counterweight engages the guides. These guides are attached by short brackets to the rear of the tower posts. To provide a support for the counterweight during deposition of the concrete, which forms the principal counterweighting mass, a pair of heavy girders spanning from front to rear tower posts was built into the tower structure. As the spans were erected in the lower (closed) position, the counterweights were at the top of their travel when constructed; provision of the girders, which gave support to a platform to carry the formwork, obviated the necessity of building up heavy scaffolding to carry the mass until ready for connection to the span. They also provided means for support of the struts in a possible emergency.

For balancing the counterweight ropes an auxiliary counterweight is used, as already noted, this being its first use in lift bridges. Heretofore, suspended chains, similar to the balancing chains sometimes used in elevators, have been applied to lift bridges, or, in many cases, no balancing of the ropes was attempted. The former counterweight involves considerable excess cost and increases the bond in the main ropes, and the latter scheme increases the demand on the machine, while the auxiliary counterweight reduces slightly the bond in the main ropes. The auxiliary counterweight, which weighs about 15 tons, is suspended from four ropes passing over sheaves back of the main sheaves and connecting to the top chord two panels out. As the span rises, the pulling angle of this rope changes, decreasing the lifting effect of the auxiliary counterweight. This counterweight system is so laid out as to balance the span in its upper position but leave about 10 tons excess downward weight of span in the lower position, this excess being desired to give the span positive bearing on its seat independent of the lock.

Power Supply and Machinery—Mounted above the top chord at midspan is a rocker bent whose upper end is connected to the top of both towers by means of a rope leading over a sheave on the tower to a small counterweight. This counterweight keeps the rocker bent constantly in such position as to hold the power cables, which run from the center towers to the rocker bent, taut in all positions of the span. The power cable thus gives a direct conductor line from the tower to the machinery house mounted on the top chord at midspan, without moving connections. This arrangement was developed partly to avoid sliding shoes for the large amount of power required, and partly to keep bare high voltage conductors and carrying parts out of the towers. It also assists in counterbalancing the shifting out of the main counterweight ropes. Patents on the auxiliary counterweight and the rocker bent have been applied for. A number of other features of the bridge are covered by existing patents.

The operating system uses double cable drive in the line of both trusses, in accordance with common practice in vertical-lift bridges. At each corner two cables, one from the tower top and one from the base of the tower, pass over sheaves at the end of the top chord and lead to a drum at midspan, where they are separately dead-ended. This drum in revolving hauls in on the one rope and simultaneously pays out the other, thus moving the span up or down depending on its direction of turning. A screw take-up is provided at the end of each of the two ropes. Thus the drive of each span involves four drums, two on each side, all four of which are driven from a common main cross-shaft by spur gearing, as shown in the machinery plan Fig. 9. This shaft is driven by two 150-hp. induction motors with resistance control through a simple train of reduction gearing, or, in emergencies, through a further reduction train driven by a Sterling gasoline engine (4-cylinder, 160-hp., for east spans; 6-cylinder, 200-hp., for west spans). The gasoline engine emergency drive contains reverse gears, and is connected to the motor pinion shafts by one of two clutches whose operating rods are connected so that one clutch is out when the other clutch is in.

Four power brakes are fitted to the electric drive, two being solenoid operated and two motor operated, which can be applied by the first three controller points or by the limit switch. When the bridge approaches either end of its travel, the limit switches cut off the power and apply the brakes several feet from the end; the span is then seated by again operating the controllers with reduced current. A combined hand and foot brake is provided for the gas engine drive.

Control System—An unusually elaborate control system is installed, which permits the lift spans to be operated either from the main operating house, located at the central point of the four lift spans, or from the machinery houses on the spans themselves. Travel indicators of the synchronized motor type are installed at these points, and navigation semaphores and lights, railroad signals, span locks, and operating machinery are controlled, all fully interlocked. The sequence of operations is as follows: (1) Set signals at danger, (2) open derails, (3) set navigation signals, (4) open rail locks, (5) unlock and operate oil switches to put power on machinery, (6) unlock span, (7) unlock controllers or gas engine controls, (8) open bridge. The east span can be raised within 1¼ min. and the west span within 1½ min.

Rail Joints—In order to provide for rail expansion, a maximum of 4¼ in. for the long span, it became necessary to devise some method by which a minimum gap could be constantly maintained between the approach rails and those on the movable bridges. The railroad company has been using mitered rail ends for drawbridges, and in view of their successful operation for a period of over twenty years it was decided to maintain a similar installation for the vertical lift bridges,

with such modifications as may be necessary to take care of the great amount of expansion. The problem was solved by anchoring the mitered ends of the rails on the lift spans to the approach when the bridge is in closed position and transferring the expansion point to long mitered rails about 25 ft. from the movable bridge expansion end. These long miters permit a movement of 4½ in. without excessive gap, and by staggering the expansion points of the two rails of a track it was practicable to protect these points by suitable guard rails. The anchoring of the mitered end rail to the approach was accomplished by a lug which fits into a recess in the shoes on the approaches, thus maintaining a uniform spacing at this point. The novel feature of the situation is the method by which the points are protected for a both-way movement of trains by efficient guard rails. Provision is made so that the end rails on the lift spans on both the expansion and fixed ends can lift in case of their hanging up on the approach rails in seating the draw spans. Their seating is protected by positive locks on each approach which engage and secure the rails as they are seated. It is further protected by electrically interlocked indicators by means of which the signal system is rendered inoperative until the rails are properly seated.

Construction Data—The four lift spans were built by the Bethlehem Steel Co., including the tower spans. They weigh about 17,000,000 lb. Each of the easterly movable spans weighs 1,600,000 lb. and each of the westerly spans 2,500,000 lb. including machinery and operating cables, or, including trackwork, 1,860,000 lb. and 2,860,000 lb. respectively. The former is not, however, the heaviest lift span, as, among others, the Louisville span of the Pennsylvania R.R. weighs 3,000,000 lb.

The long plate-girder approaches were fabricated and erected by the American Bridge Co. and weigh about 20,000 tons. The viaduct approach at the east end was fabricated and erected by the Bethlehem Steel Co. and weighs 4,000 tons. Electrical installation was by the Norwood-Noonan Co., of Chicago.

Owing to the heavy travel on the existing bridge, all steel for the portion of the new bridge over the water was delivered on barges and erected without encroaching on the existing line. The heavy girders, erected by the American Bridge Co., were delivered at the site of the work on a special deck scow, provided with an incline frame running longitudinally through the center so that eight girders, four on each side, with their crossbraces, were delivered at one time. These girders were handled from the deck scow to their position in the bridge by means of Merritt-Chapman steam derrick "Colossus." As soon as the operation was well under way, eight girders were set per working day. The cast-steel shoes had been placed upon the piers in advance of the girder erection.

On the main drawbridge section, erected by the Bethlehem Steel Co., the steel was sorted in its Moore plant at Elizabethport and brought to the bridge on barges and thence handled into the structure by means of a special tower erected on two barges, side by side, framed together by means of heavy girders to act as a single unit. This tower was 140 ft. above the surface of the water and on the top was a derrick with an 85-ft. boom. This derrick was able to reach the highest portions of the towers and also was used to set the large cast-steel sheaves. In addition, as the tower completion permitted, small derricks with gasoline engines were placed alternately on top of each of the towers to handle miscellaneous parts and the concreting of the counterweight.

A further feature of the erection which made for speed and economy was the use of only one set of falsework in each channel. It was required that at all times one of the two channels be kept open for navigation. This falsework was placed in position for the northerly bridge and upon it was first erected the steelwork for the southerly bridge with the ends at the piers resting on heavy carriages on rails placed on blocking upon the piers and upon the completion of the erection of each of the southerly spans they were rolled over to their position, thus clearing the falsework for immediate continuation of the erection of the northerly span on the same set of falsework. Attention is directed to the fact that had the falsework been erected for the southerly bridge, owing to the existing old bridge being immediately south it would have been necessary to omit the building of the falsework for the northerly span until the southerly bridge was erected and the equipment moved clear.

In both the case of the main girder section and the erection of the main drawbridge with its towers, the work was done in one season, so that the difficulties which would have been met on account of ice conditions north of the bridge were avoided.

The steelwork for the viaduct section at the east end of the bridge was brought to the site by water, up to the beginning of the land section, at which point a track was laid for the purpose and the steel brought on cars clear of the main line. This steel was handled by means of a traveler in the usual manner.

Personnel—The work was designed and carried out under the direction of the engineering department of the Central Railroad Company of New Jersey, A. E. Owen, chief engineer, J. J. Yates, bridge engineer, A. M. Zabriskie, principal assistant engineer, and H. E. VanNess, construction engineer.

Railway Development in Australia

While most of the railways of Australia are owned and operated by the governments of the several states, there are four lines, aggregating 1,733 miles, which are owned by the federal government. These are the Trans-Australian Ry., from Kalgoorlie to Port Augusta, 1,051 miles; the Oodnadatta Ry. and Northern Territory Ry., 477 and 198 miles, which are the ends of a future north and south transcontinental line, and the 4-mile line to the federal capital city at Canberra. These railways are in the general interests of the commonwealth rather than those of the states which they traverse. Plans are still under consideration for building the long middle link of the north and south line, crossing unsettled and partly desert country. Troubles due to variations in gage are gradually being reduced. In the report of the commissioner of commonwealth railways for 1925, it is stated that the federal government and the state governments have entered into agreements for changes which will give a continuous line of standard gage between Sydney and Brisbane, and a similar line between Adelaide and Kalgoorlie. This latter is now composed of three different gages, and beyond Kalgoorlie there is still a long line of 3½-ft. gage to the west coast.

Comparison of Brick and Asphalt Pavement Repair Costs

Based on Records for 36 Years for Asphalt and 24 Years for Brick, Kept in Columbus, Ohio, City Engineer's Office

By R. H. Simpson
City Engineer, Columbus, Ohio

In Engineering News-Record, July 23, 1925, p. 140, R. H. Simpson, city engineer of Columbus, Ohio, presented a remarkable record of asphalt pavement repair costs covering a period of 36 years. More lately a similar summation has been completed for brick pavements and the figures charted as were the asphalt pavement figures. Comparison also has been drawn between asphalt and brick and the results given in a paper for the Des Moines, Iowa, convention Oct. 26-28 of the American Society for Municipal Improvements. The following data are taken from this paper.—Editor.

With the literature on roads and pavements so voluminous, it is astonishing that so little is known of, or so little has been published on, wear or maintenance cost. It is true, of course, that many figures on the maintenance cost of roads are given in the reports of various highway departments, but they are usually in terms of cost per mile, and include a lot of miscellaneous work other than the actual repairs to the pavement, and, therefore, it is impossible to make comparisons. There are also occasional reports made on repair costs of city pavements. These are also usually in such terms that it is difficult to form a basis for definite conclusions and comparisons. For instance one frequently sees a report from some city that the cost of maintaining a certain type of pavement for a certain year was 2c. per yard and that the cost for another type during the same year was 2½c. per yard, and the inference is that the latter is the more expensive type from the standpoint of maintenance. This may or may not be true. Unless other factors affecting the cost are stated, such as the relative age of the pavements and the character and volume of traffic carried, this information is usually misleading.

To illustrate it may be stated that during 1924 there was expended on the 3,900,000 yd. of brick pavements in Columbus about $90,000 or $0.023 per square yard and on the 1,800,000 sq.yd. of asphalt pavements about $19,000 or $0.011 per square yard. This would indicate that the repair cost for brick pavements is more than twice as much as for asphalt pavements, which is not true, the greater cost for brick being due, in part, to the fact that the average age of the brick pavements is greater than that of the asphalt. As a pavement becomes older it will cost more for maintenance and unless the age of a pavement and something of the traffic it carries are known the repair cost does not mean much. In the data presented herein, the repair costs are given in terms of the age of the pavement and the analysis shows costs compared for light and heavy traffic.

Construction—Prior to 1900 the asphalt pavements in Columbus were laid on a 6-in. natural cement concrete base, except for a few improvements, where old boulder pavements were resurfaced with asphalt. Subsequent to 1900 a portland cement base 6 in. in thickness has been used. During the first few years the concrete mixture was 1 part cement, 4 parts sand and 8 parts crushed stone or crushed gravel. This mixture has been strengthened from time to time and for the past twelve years the proportions have been 1 part cement, 2½ parts sand and 5 parts stone. The thickness of foundation has remained at 6 in. Subsequent to 1900 the use of subdrains along each curb line has been standard practice. During the past twelve years about 175,000 sq.yd. of asphalt has been laid over old brick pavements. The asphalt mixture has followed standard practice in sand grading and has contained from 10 to 11 per cent bitumen. About 82 per cent of the yardage is Trinidad Lake asphalt and 18 per cent oil asphalt. On most of the improvements the wearing surface has been 1½ in. of sheet asphalt laid on 1½ in. of binder. During the past ten years, however, a 2-in. sheet asphalt top has been used almost exclusively on heavy traffic streets.

Prior to 1900 the brick pavements were laid on a macadam base, the joints in most cases being filled with coal tar pitch. Subsequent to 1900 the base has been the same as described for asphalt pavements. Between 1900 and 1910 pitch was used almost exclusively for the filler. From 1910 to 1915, a cement filler was used on a considerable portion of the pavements. Since 1915 asphalt filler has been used almost exclusively. Both shale and clay brick have been used and since 1900 the standard rattler test has been required on all construction.

Maintenance Methods and Records—Practically all repairs on asphalt pavements have been by the "cut out" method. Surface heaters have rarely been used. Prior to 1907 the asphalt repairs were made by contract, the repaired area being measured and payments made on a unit price basis. Since 1907 all repair work has been done by city forces. To ascertain the cost of repairs of asphalt pavements, the repaired area is measured and recorded at the time the repair is made, but the unit cost to be applied is determined at the end of the season's work, by dividing the total expense for the year, including labor, material, supplies, repairs to equipment and plant, a charge for use of plant, superintendence, etc., by the total yardage of repair made. This gives a unit cost to apply to each pavement and a total for it, that is not influenced by the location of the pavement nor its distance from the plant. A more rational comparison between pavements is thus obtained than by using actual repair cost of each improvement.

The repairs to brick and block pavements are handled by small crews furnished with the necessary supplies, tools and equipment for such work. These crews are supervised by a general foreman who measures all repaired areas. In the case of brick and block pavements the actual cost of the work in each particular improvement is recorded as the work progresses, to which is added 15 per cent to cover the cost of handling materials at the yards, the repairs to tools and equipment, superintendence, etc.

The maintenance of pavements in Columbus has always been under the direction of the Chief Engineer of the Service Department, and in direct charge of two deputy engineers, one on asphalt repairs and the other on other types. A record of the repair costs has been kept for many years past. In the case of asphalt the record is complete for all pavements constructed since 1888, and for brick and other types constructed since 1900. The work of tabulating and classifying the figures has been completed for all asphalt and brick pavements, about 1,000 separate improvements, totaling 5,700,000 sq.yd., of which 1,800,000 sq.yd. are asphalt and 3,900,000 sq.yd. brick. At the end of the year the repair costs for all pavements are recorded on cards prepared for the purpose, one side showing the construction data and the reverse side the maintenance. (One of these cards was shown in *Engineering News-Record*, July 23, 1925, p. 140.—Editor.)

Cost Record Charts—Fig. 1 shows graphically the repair costs of brick pavements from one to 24 years. The figures were obtained in the same manner as described in *Engineering News-Record*, July 23, 1925, p. 140, for asphalt and represent an average cost of all pavements in the city without considering any variation in volume or weight of traffic. It will be noted that the increase in cost is uniform from the first to the fourteenth year. The period of heavy maintenance is at the fifteenth and sixteenth year and following a decrease is rather rapid up to the twenty-second year. The low cost for the last two years is due to the fact that the only pavements of this age have carried very light traffic.

Fig. 2 shows a comparison of the cost of repairs of light and heavy traffic brick pavements, the division into these two classes being made in the same manner as described for asphalt pavements. It will be noted that for the heavy traffic pavements the increase in repair cost is rather uniform and rapid for the first fifteen years, reaching a maximum at the latter age period. The cost drops following this period but increases again to a higher maximum for the twenty-first year. The cost for light traffic pavements increases rather uniformly to the twenty-second year, reaching a maximum at that period.

Fig. 3 shows a comparison of repair costs for brick and

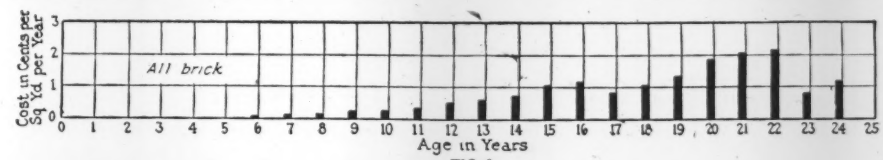


FIG. 1

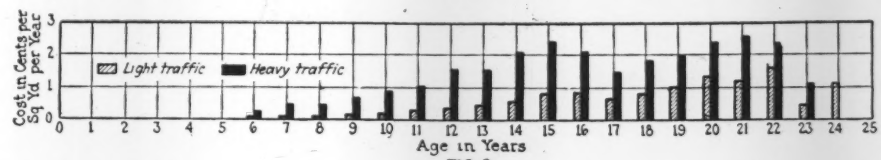


FIG. 2

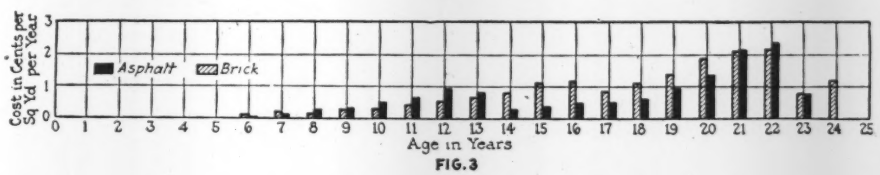


FIG. 3

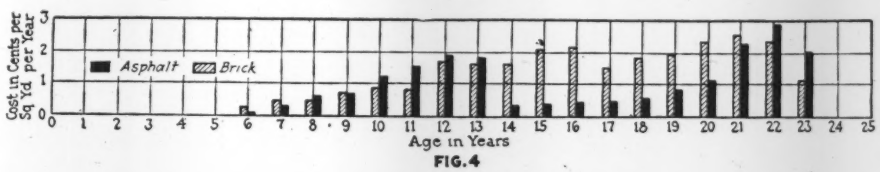


FIG. 4

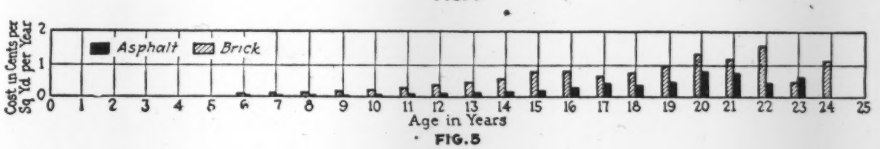


FIG. 5

FIGS. 1 TO 5—REPAIR COST CHARTS, BRICK AND ASPHALT PAVEMENTS, COLUMBUS, OHIO

Fig. 1—Brick repair costs for all pavements.
Fig. 2—Repair costs compared for light and heavy traffic brick pavements.
Fig. 3—Asphalt and brick repair costs, all pavements.
Fig. 4—Asphalt and brick repair costs, heavy-traffic pavements.
Fig. 5—Asphalt and brick repair costs, light-traffic pavements.

asphalt pavements. This comparison is for those pavements constructed since 1900, the same type of base being used for both. It is interesting to note that there are two periods of heavy maintenance on each type, the repairs on asphalt reaching a maximum at the twelfth and twenty-second year and those on brick at the sixteenth and twenty-second year. It will also be noted that during the earlier years the repair cost for asphalt is a little higher than for brick at same ages while the reverse is true for the later years, the repair costs for brick being in excess of asphalt from the fifteenth to the twentieth year.

Fig. 4 shows a comparison of repair cost for heavy traffic brick and asphalt pavements. It will be observed that on the former the cost increases with the age at a fairly uniform rate from the sixth to the fifteenth year. Beyond the latter age there is a lower cost for a few years followed by an increase which attains the maximum at the twenty-first year. The repairs for asphalt maintenance show a marked increase in cost during the earlier years with a maximum at the twelfth year. Following this there is a decided lower cost from the fourteenth to the twentieth year with another marked increase which reaches a maximum at the twenty-second year. It is interesting to note that there is a period of heavy repair cost on both types of pavement, the cost on asphalt reaching a maximum a few years before that on brick, but the cost for the latter being greater than the former from the fourteenth to the twenty-first year.

Fig. 5 shows repair costs compared for light traffic brick and asphalt pavements. It will be observed that the costs on both types increase with age at a fairly uniform rate, both reaching a period of maximum cost at the twentieth year. It will also be noted that the cost for brick is in excess of the asphalt at all ages, the difference being marked after the tenth year.

Analysis of Records—A study of the data from which these diagrams were constructed has disclosed the fact that a surprisingly large number of pavements, considering each separate improvement as a unit, have been in service for many years before requiring any repair. As would be expected, most of these are light traffic pavements, although a few pavements carrying moderately heavy traffic have reached the age of ten years before repairs were made. As an illustration it may be stated that of the 599 brick improvements that have completed ten years of service, with an area of 1,897,511 sq.yd., 351 pavements, comprising a yardage of 911,129, were in service ten years before any repairs were made. This represents 48 per cent of the yardage of ten-year-old brick pavements. The asphalt pavements show about the same percentage at the ten-year period. It is clear, therefore, that the entire cost of repairs on ten-year-old pavements has been expended on about one-half of the yardage of those pavements. The figures show that on thoroughfares where the traffic can spread out over the entire pavement the maintenance is moderate, even where the traffic is large in volume, and that a large portion of repair costs has been expended on thoroughfares where the traffic is concentrated in a narrow path by reason of the location of street railway tracks in the center and parked cars along the curb.

Fig. 6 shows graphically the yardage of asphalt pavements requiring no maintenance compared with the total yardage at various ages, and Fig. 7 gives the same information for brick pavements. It will be observed that a

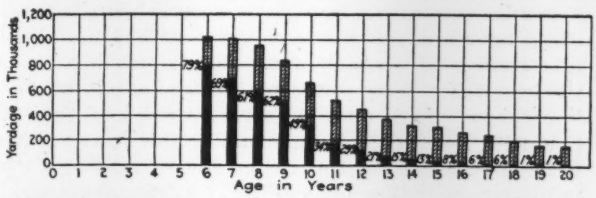


FIG. 6—ASPHALT YARDAGE WITHOUT MAINTENANCE EXPENSE

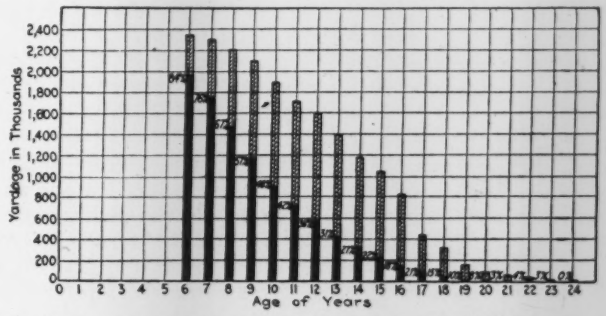


FIG. 7—BRICK YARDAGE WITHOUT MAINTENANCE EXPENSE

large percentage of the pavements have given service for ten years without maintenance cost, but as would be expected the percentage decreases very rapidly as the pavements become older.

As was noted, the diagrams showing repair costs for heavy traffic pavements indicate a pronounced rise in cost during the earlier ages. The exact period when this rise occurs is no doubt influenced by several factors such as sub-soil conditions, construction details and traffic carried, and will vary in different localities. On the pavements under consideration it has occurred from the 10th to the 12th year after construction on asphalt pavements and in the 15th year on brick. Following this period of abnormal maintenance, there is a reduction in cost for several years which is quite marked for asphalt. It should be clearly understood, however, that this period of heavy maintenance is not common to all pavements as was shown by the last diagrams. Our records show, however, that it occurs on most of the heavy-traffic and on some light-traffic pavements.

On account of the fact that the period of heavy maintenance is not noticed on all pavement and that its occurrence is uncertain, this period may be called the critical period in the life of pavements. They may pass this period successfully by reason of light traffic or other favorable conditions, or they may develop a weakness before this time by reason of some abnormal condition, but the figures seem to indicate that defects, either in sub-base, foundation or wearing surface, do not necessarily develop until this critical period, and we should not form any definite conclusion as to the merits of a pavement until this critical period has been passed. As indicated by the diagrams, the average heavy traffic pavement, after passing the critical age period continues to render service at a less repair cost for another period of years, after which the cost reaches a new and higher maximum. This would seem to indicate that the period of heavy repair cost occurs at cycles, the length of which would vary for different types.

From a study of the figures we can conclude that the repair cost of the average asphalt or brick pavement is moderate at all ages. Expressed in terms of cost per mile for a roadway 18 ft. in width, it would average, on pavements constructed subsequent to 1900, at six years of age approximately $7 per mile per year, at 15 years of age $80 per mile per year, and at 25 years of age $200 per mile per year. Our oldest asphalt pavement constructed in 1888 has cost 3.2c. per yard per year during its life, which expressed in terms of an 18-ft. road would be $338 per mile per year.

Differentiating Between Concrete Disintegrations

In a paper presented to the Engineering Institute of Canada at its annual meeting in January, P. J. Mackenzie, dean of engineering, University of Saskatchewan, and Dr. T. T. Thorvaldson, professor of chemistry at the same institution, described some investigations that have been conducted under the auspices of a committee of the Engineering Institute of Canada which is looking into the effect of alkali ground waters on concrete. This specific investigation has resulted in the development of methods to distinguish between the three different agencies which cause concrete disintegration; that is, alkali water, acid water, and frost. The chemical methods devised are detailed in the paper. In effect, the concrete disintegrated from sulphate action can be detected by the high SO_3 content (above 1 per cent) of the disintegrated residue. This distinguishes clearly between the sulphate action and frost action. Acid action is detected by low loss on ignition and the presence of the proper acid radicle in the disintegrated cement. The paper finally recites the results of an investigation into disintegration which appeared in a concrete sewer in which all three kinds of disintegration were found and detected by the methods described in the paper.

Terminals and Towboats for Inland Navigation

RIVER or waterway terminals for transfer of freight between water and land transport are of three general types—the direct lift, the conveyor and the floating terminal with railroad incline—according to a paper presented at the annual meeting of the Society of Naval Architects and Marine Engineers, by Brigadier-General T. Q. Ashburn, U. S. A. The adoption of any type depends upon various factors, including the character of the stream, the principal commodities handled and the existence of railroad connections, but for the Mississippi River the third type is considered by General Ashburn as the most suitable.

An essential to successful operation of waterway service is a balanced traffic including high- and low-revenue freight in both directions, and this can be obtained only by a permanent service with regular scheduled sailings. Interchange with railroads is also essential, as otherwise only local freight could be handled, which would not benefit the public at large. The Inland Waterways Corporation has interchange relations with 165 railways. Although the government's project for improvement of the Mississippi River calls for an 8-ft. channel 250 ft. wide from Cairo to St. Louis, and a 9-ft. channel 300 ft. wide from St. Louis to New Orleans, there is at present only a packet-boat channel for drafts of 6 to 6½ ft., according to General Ashburn, who would limit the draft of towboats to 5 ft. 3 in. in order to maintain ample clearance and to allow the water free flow to and from the propellers.

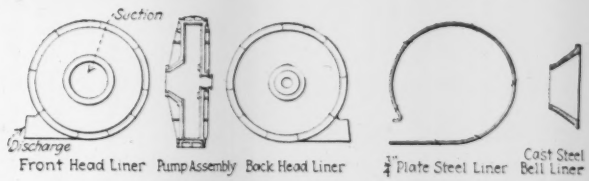
Three classes of service now operated include: (1) Self-propelled 280-ft. barges of 2,000 tons carrying capacity, making the trip between New Orleans and St. Louis in 10 days upstream and 5½ days downstream; (2) express towboats which push three 2,000-ton barges upstream in 13 days and downstream in 6 days; (3) heavy tows of six or more 2,000-ton barges, making the trip in 18 and 6½ days. These times include stops.

For towboats to operate between St. Louis and Memphis, where the channel frequently is not more than 6 ft., it has been determined that 63-in. draft and 1,500-hp. engines make a desirable combination, and the Diesel engine is preferred for practicability, efficiency and economy. The new boats are to be 200x40 ft., 10 ft. deep, with twin screws driven by Diesel engines aggregating not less than 1,500 hp.

Screw and Stern-Wheel Towboats—River towboats of the propeller type, with twin screws operating in tunnels formed in the hull, have an advantage over stern-wheel towboats in lighter weight and displacement, according to a paper read at the same meeting by Captain William McEntee, U. S. Navy. This paper dealt with tests of different designs of shallow-draft towboats for inland navigation, where the boats push fleets of barges placed ahead of the towboat. All the propeller boats had Diesel engines of 350 or 750 hp. each, while the stern-wheel boat had Diesel-electric drive of 550 hp. With this method of pushing a fleet of barges having no rudders, the rudder power of the towboat is of high importance. Tests on a large twin-screw boat indicate that with four rudders maximum rudder power is had with one rudder on the center line, forward of the propellers, with the other three between and outside of the propellers and abreast of them.

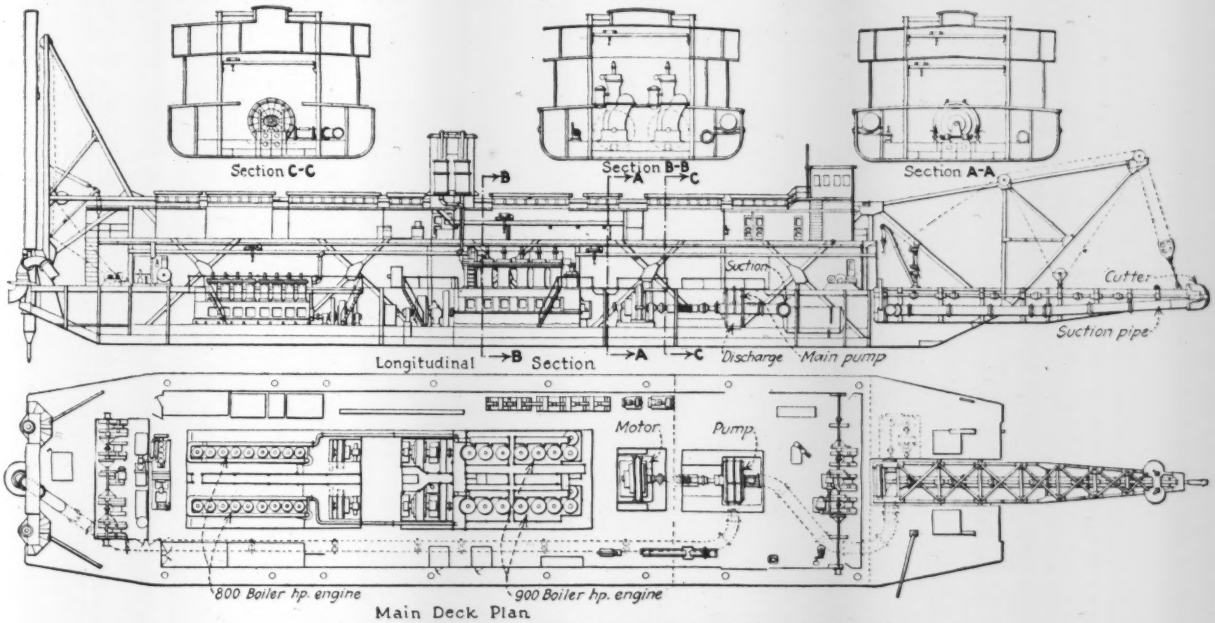
Large Diesel Electric Dredge Built for Portland

High Power, Speed and Flexibility of 30-In. Dredge Make New Records Possible on River Work at Portland, Ore.



PUMP ASSEMBLY SHOWING LINERS

IN THE river channel and harbor-improvement work being done by the Port of Portland dredge fleet there is frequent need for handling large quantities of material through long pipe lines. Heretofore this work has necessitated the aid of booster pumping units in the delivery lines. In planning for an addition to the fleet last year, however, it was decided to build a much more powerful dredge than any heretofore used, in which flexibility and economy of operation could be combined. Based on extensive experience with suction dredges, plans were accordingly drawn up for the dredge "Clackamas" equipped throughout with electric motors served with power from main generators operated by Diesel engines developing a total of 3,400 b.hp. The main pump has constant power over a speed range of 250 to 360 r.p.m. and there is an equally desirable range of control in cutter operations. The main features of the "Clackamas," which has been in operation since last August, are set forth in the following:



PLAN, ELEVATION AND SECTIONS OF THE CLACKAMAS

In making plans for the new dredge it was decided to depart from the practice of designing the power plant to use hogged fuel (saw-mill waste). Although cheap and plentiful in the vicinity of Portland, this fuel is bulky and requires the continual maintenance and towing of barges which make delivery by mooring alongside a dredge so that the fuel may be fed direct from barge to furnace. At times a barge so moored restricts the swinging space of the dredge and any shutdown of the mills of interference with navigation that precludes delivery from distant mills necessitates shutdown of the dredge.

The hull of the "Clackamas" which was fabricated in Seattle and assembled in Portland is of steel with a length of 236 ft. and a 50-ft. beam. The depth is 12 ft. 9 in. and the displacement 2,480 tons at a draft of 7 ft. 8 in. which includes a week's supply of fuel oil with other stores for three months' operation.

Since three dredges of this fleet have been sunk, two from being rammed by steamers and one by the bursting of a discharge pipe, particular attention was given to the construction of the hull to make it strong enough to hold the heavy Diesel engine equipment and minimize damage that might result from collision. On each side of the hull, 7 ft. inboard from the shell plating, a longitudinal watertight bulkhead extends from the forward athwartship bulkhead to the after athwartship bulkhead. This also strengthens the hull, particularly the bottom, and will offset stresses in case of grounding.

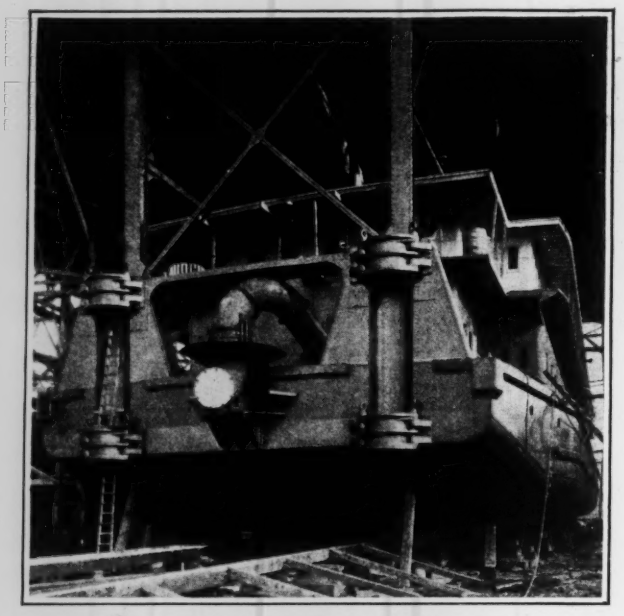
Space between this bulkhead and the side of the hull is divided by athwartship partitions into six watertight compartments on each side, which are used for storage of supplies and materials.

Between the longitudinal bulkheads transverse watertight bulkheads divide the hull into six compartments. This design greatly increases strength by the insertion of braces between the main machinery units and thoroughly ties the machinery keelsons to the longitudinal bulkheads and sides of the hull. By this arrangement, too, each Diesel engine with its generators, the main pump motor and the main dredging pump are all in separate compartments. Should the bottom of the dredge be injured, or should the pipe line burst, causing the filling of any one of the compartments, the damage would be local and would affect the electrical equipment in the one compartment only.

Extending the full length of the hull are two heavy bridge type steel trusses. The forward ends of these are continued to form the A-frame for the ladder hoist and the after ends are tied into the spud masts. These trusses, located halfway between the dredge center line and the side plating of the hull, are calculated to support the weight of the dredge in case of grounding on the two ends. Panel points are 35 ft. apart and the angle of diagonal members is approximately 45 deg.

The spuds are 80 ft. long and 35 in. in diameter, constructed of ¾-in. steel plates rolled into a cylindrical tube in which flanged diaphragm plates are riveted at 5-ft. intervals to take care of beam strains. Spuds of this construction are said to have double the strength of timber spuds and are easily repaired or rebuilt in case of injury. The spud wells are formed with heavy cast-steel hinged keepers which make it easy to remove the spuds in case they are bent. The spud masts are high enough to take the 80-ft. steel spuds and are so designed that they may be used to ship or unship a spud in case of breakage. The dredge crew can readily replace a damaged spud without outside aid.

The power installation consists of two 800-b.hp.



REAR VIEW, DISCHARGE PIPE AND SPUD WELLS WITH KEEPERS

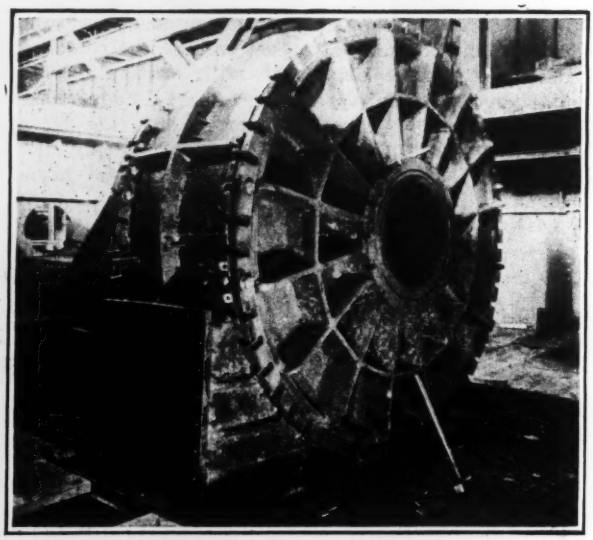
Diesel engines, stationary type, each direct-connected to a 540-kw. d.c. generator and two 900-b.hp. marine type Diesel engines, each direct-connected to a 610-kw. d.c. generator. The 800-hp. engines are 8-cylinder units and at full power turn 200 r.p.m. The 900-hp. engines are 6-cylinder units, turning 150 r.p.m.

The fuel-oil consumption for the four engines, totaling 3,400 b.hp. is 102 bbl. per day of 24 hr. when the engines operate continuously at full speed. However, the average pumping time usually does not exceed 20 hr. per day and this with the varying loads of normal operation will require the consumption of only 70 to 75 bbl. per day on an average.

Though possessing four power units it is possible to operate to 80 per cent efficiency in many cases with only three. Thus a breakdown of one unit would not seriously hinder the operation of the dredge and on short pipe lines it might even be advisable to operate continuously with one or more engines out of service.

This was demonstrated on the Swan Island project pumping heavy sand and pea gravel through approximately 4,700 ft. of pipe line against a net terminal lift of 29 ft. With four engines operating full power, the dredge maintained a pipe-line velocity of 17.2 ft. per second, a pressure of 65 lb. per sq.in. and 18-in. vacuum.

For one day it was necessary to run on three engines only while some governor adjustments were made to one of the 900-hp. engines. The pipe-line velocity fell to 15.4 ft. per second, the pressure to 50 lb. and the vacuum to 12 in. Due to the nature of the dredging



30-IN. DREDGING PUMP SHOWING SUCTION AND DISCHARGE OPENINGS

conditions it was not possible to measure the daily output in cubic yards or the percentage of solids being handled.

All electrical equipment is direct current, which was selected because it was believed to be simpler to handle and to require less expert attention.

The main dredge pump is a high-speed, square-volute, lined centrifugal pump, developed by the Port of Portland especially for the work. It has 30-in. suction and discharge openings and a rectangular casing section, 8 ft. 10 in. in diameter inside of the liners which are made of ¾-in. mild steel. The casing is 2 ft. 3 in. wide inside the liners and to give maximum strength and minimum weight is made of cast steel. The design is considered the best to resist breakage from boulders or water ram, and also to facilitate repair and lessen upkeep costs. The rectangular section concentric with the impeller simplifies the machining of head and periphery liners. These liners are made in sections to minimize the expense of replacing any worn parts.

The impeller, which screws onto the pump shaft so that it may be readily removed to replace the back head liners, is of the four spiral-vane enclosed type, 70 in. in diameter. With the wide speed range available the one impeller is expected to work effectively with heavy or light materials, long or short discharge lines and low or high terminal lifts. The impeller shaft is made of nickel steel, 11 in. in diameter, and where it passes through the pump casing runs in a self-aligning bearing.

The main pump motor is of 2,700 hp., and 500 volts, with adjustable speed, and is compound-wound. It is direct-connected through a flexible coupling and marine horseshoe-type thrust bearing to the dredge pump. The use of motor-driven rheostatic controllers operated by push-buttons permits a speed range of 250 to 360 r.p.m. The compounding is adjustable to give a no-load speed of 450 r.p.m. and a full load speed of 360 r.p.m. with a rising speed characteristic giving additional velocity and maintaining torque to clear the discharge pipe line in case of choking.

The cutter is driven by an electric motor through a gear train. Two of the gears in this train are made interchangeable so that the maximum speed of 12 r.p.m. in the cutter head can be thereby increased to about 25 r.p.m. The cutter drive consists of a 250-hp., 600-r.p.m., 250-volt, d.c. shunt-wound motor, arranged for operation from a variable-voltage generator. The forward swing hoist is operated by a 75-hp. motor while 45-hp. motors are used on the forward ladder hoist and stern hoist.

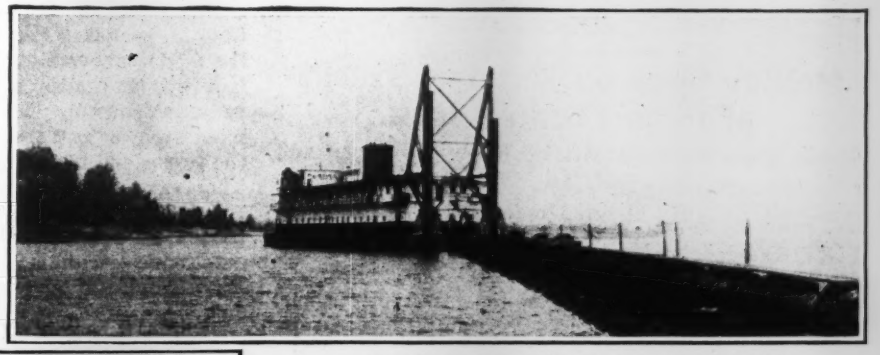
The dredging ladder is the standard Port of Portland design, 75 ft. long, 10 ft. wide, and 8 ft. 6 in. deep, of open rectangular frame construction. Four heavy structural steel angles, one in each corner, separated into panels by diaphragms spaced approximately on 10-ft. centers with cross-bracing and plate gussets extend the full length of the ladder. The cutter shaft is carried in bearings near the top while the suction pipe, also inside the ladder, is carried in saddles near the bottom. This construction allows the cutter to worl in very shallow dredging without dragging the ladder on the bottom during the swing. The suction pipe passes from the ladder into the hull through a packing gland in the starboard trunnion and thence to the dredging pump. Here an easily removable section is located with a manhole on its upper surface for inspection purposes and for removing foreign material that lodges at the pump entrance. The discharge line from the the pump passes aft on the starboard side below the main deck rising at the stern to connect through a gooseneck bend, a packing gland and swivel elbow to the pontoon pipe leading ashore.

COMPARTMENT FOR 800-HP. ENGINES SHOWING TRUSSES AND BULKHEAD

The cutter shaft is driven by a heavy train of gears and a shaft passing through the port trunnion from the cutter-motor gear train. This shaft is of steel, 8½ in. in diameter, increased to 10 in. at the cutter head bearing and tapered square where fitted into the hub of the cutter.

The crew of the dredge, sufficient for continuous operation on three 8-hr. shifts, consists of 50 men. Ample living quarters have been provided, including social halls and other facilities to make the boat comfortable on long-continued runs.

Although the "Clackamas" has not as yet been in service long enough to permit of long operating records, results thus far indicate that it will come fully up to the expectations of the designers.



VIEW OF THE CLACKAMAS IN SERVICE

The following is an actual operating comparison between the "Clackamas" and the "Tualatin," one of the Port's 30-in. steam dredges, operating with the aid of a 1,600-hp. motor-driven 30-in. booster unit. The steam dredge, due to its limited power, could not handle this particular job in a satisfactory manner without the aid of the booster. The dredging conditions were identical, light bank, heavy lift, long pipe line, and a heavy material (sand and gravel) that required high pipe-line velocities. The dredges were changed purposely to draw a direct comparison under these particular conditions. The material being dredged and the nature of the work was such that no dredging record could be made for output.

	Steam Dredge "Tualatin" 2,000 rated hp. with booster 1,600 rated hp. Total hp. 3,600	Diesel Electric Dredge "Clackamas" 2,700 hp. at pump motor
Dates of operation	Aug. 1–31, 1925	Sept. 1–30, 1925
Total elapsed operating time, hr.	624.00	600.00
Total pumping time, hr.	454.67	432.63
Per cent of time pumping	61	60
Cubic yards dredged	259,630	413,230
Cubic yards per pumping hour	571	955
Maximum length pipe line, ft.	7,750	8,520
Average length pipe line, ft.	5,944	6,273
Average lift, ft.	29.2	29.1

For making comparisons which will reflect elements obviously affecting output; namely, length of pipe line and lift above water level, the Port of Portland uses the "transport unit." This unit is equal to 1,000 cu.yd. pumped through 100 ft. of pipe line with one foot of lift—a fair comparison when dredges are on the same location and material. Comparisons on this basis showed the following results:

	"Tualatin"	"Clackamas"
Total transport units	450,574	754,273
Transport units per pumping hour	991	1,744
Percentages based on "Tualatin's" output taken as 100 per cent		
Transport units, per cent	100	176
Cubic yards output, per cent	100	167
Estimated cost per cubic yard	.094	.038
Estimated cost per 1,000 transport units	$54.24	$21.21

A comparison of the Diesel engines with the steam

engines previously used, according to officials of the Port Commission, shows that the "Clackamas" will deliver power to the dredging pump at 72 per cent of the cost per horsepower on the other dredges. This is without considering the labor cost of transferring the hogged fuel from barges to the furnaces. As compared to using fuel oil under the boilers of the other dredges (which has been necessary in times of hogged fuel shortage) the cost per horsepower at the pump is more than four times the corresponding cost on the "Clackamas."

The "Clackamas" was designed by the Port of Portland engineering corps under the direction of James H. Polhemus, general manager and chief engineer, to whom *Engineering News-Record* is indebted for the foregoing information.

Melting Snow on Terminal Tracks of Illinois Central R. R.

Steam Pipes Laid on Ties of Exposed Tracks and on Ballast at Switches—Snow Dumped Into Steam Heated Pits

IN THE extensive improvements to the Chicago terminal system of the Illinois Central R.R., special provision is being made to avoid delays to railway traffic due to the blocking of tracks and switches by snow and ice, since such delays are particularly objectionable and serious in suburban and terminal service. This provision includes three distinct methods: (1) The laying of steam pipes upon the ties and parallel with the rails; (2) the placing of steam coils between the ties at switches, and (3) the construction of snow-melting pits between the tracks, having steam pipes and jets to melt snow which is cleared from the tracks and shoveled or dumped into the pits. The first method is quite novel, but the others have been employed before on parts of the company's terminal lines.

Protection of Incline Tracks—At the connection of the South Chicago branch with the main line, a flying junction is used to avoid interference with other tracks, the two branch tracks descending on a 3 per cent grade so as to pass under the right-of-way in an underpass or subway. Since the open part of this incline, which part is as short as possible, might be blocked seriously by heavy snow, it is protected for its entire open length of 365 ft. by a steam-radiator system, supplemented by ample drains for carrying off the melted snow in addition to ordinary surface drainage.

A supply main, ranging in size from 4 to 2 in., is led to pits, about 73 ft. apart, between the two tracks, as shown in Fig. 1, and at each pit it is connected to two 3-in. transverse headers laid in the roadbed and about 16 in. below the base of the rail. From each header are run five lines of 2-in. pipe about 73 ft. long, ending in a 2-in. return header which is level with the bottom of the ties and leads to a steam trap with drain connection. These traps are placed in small pits. Of the five lines of radiator pipe for each track, two are laid along the ends of the ties and three between the rails. An ample supply of valves is fitted to regulate the distribution and insure circulation of steam in the several radiator sections.

The main steam pipe and its headers will remain in position permanently, but the radiator pipes and return headers will be placed early in the winter and removed in the spring. The steam-supply main is laid in a 10-in. conduit formed by a concrete box 15 in. square, the upper half of which is removable. Cast-iron rollers or spindles at intervals allow for expansion and contraction movements of the pipe, while anchorages at certain points hold the pipe against longitudinal movement. To prevent displacement of the radiator pipes on the ties they are secured to cast-iron saddles on the end ties by means of bent bars which fit over the pipe and pass through lugs on the saddle. An 8-in. vitrified tile drain is laid in the roadbed between the tracks, and the melted snow flowing down the incline is carried away by sewer connections.

Protection of Switches—To prevent the clogging or freezing up of the switches connecting the South Chicago branch tracks with other tracks, at the top of the incline above mentioned, horizontal steam coils are laid between the ties for the entire length of the switch rails, as shown by plan and section in Fig. 2. A supply main from 3 to 2 in. in diameter is laid parallel with the tracks and to this are attached 1¼-in. radiator pipes. There are three separate coils at each switch, each coil being connected directly to the steam main and having its own valves to regulate both supply and circulation, as with a single connection and a long coil there would be little heat at the farther end in very cold weather.

Each coil is connected to a 2-in. return pipe which discharges into a catchbasin or is led to a pit containing a steam trap draining into an 8-in. vitrified pipe drain ending in a sewer connection. Condensation in the supply main is handled by a 1-in. or ½-in. drip pipe connected to the steam trap. The radiator coils are not embedded in the ballast, as such an arrangement would involve an excessive amount of work in placing and removing the pipes each season, while they would also interfere with track maintenance work. They are placed, therefore, on the ballast at about mid-height of the tie, the ballast being leveled off for that purpose when they are installed. Snow melted on the tracks flows from the roadbed to catchbasins which are connected to an 8-in. vitrified pipe drain laid below the subgrade. These catchbasins are of brick, 3½ ft. in diameter and 6 ft. deep, with tongue-and-groove plank floor. The drain enters 2 ft. above the floor.

Snow Melting Pits—Prompt removal of heavy snow from terminal tracks is a difficult problem, since shoveling into cars is a slow process and may be impracticable, while carrying it by hand shovels to a space clear of the tracks is slow and often dangerous work. To meet this condition, concrete pits about 6½ x 3 ft. and 20 in. deep are provided at intervals of about 95 ft. between some of the tracks and also adjacent to the heating installations described above. A typical pit is shown in Fig. 3. When not in use they are covered by steel checkered-plate lids.

At the bottom of each pit, a branch from the steam main is connected to a header from which run ten horizontal 2-in. galvanized pipes, having ⅜-in. holes at an angle of about 45 deg. on each side, and spaced 4 in. apart. Thus the heat of the pipes is supplemented by live steam jets to melt the snow which may be shoveled into the pit. The header at the opposite end is connected to a return pipe leading to a steam trap. An outlet drain pipe with grated inlet above the floor is connected to the 8-in. pipe drain already noted.

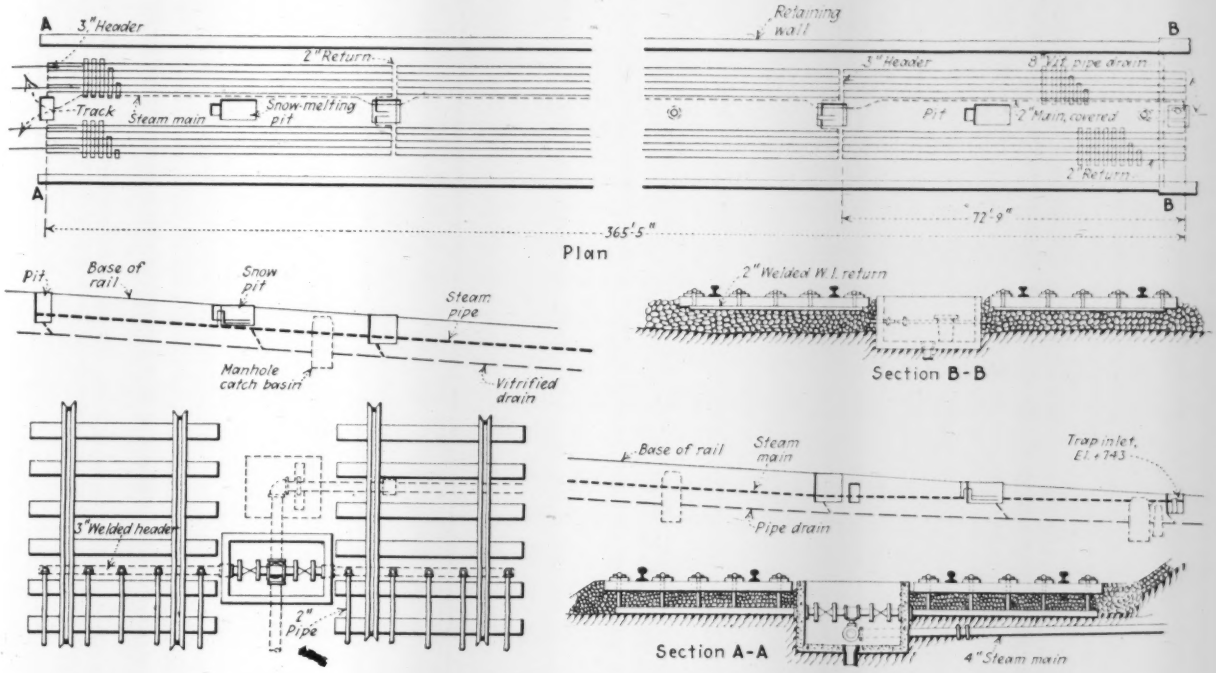


FIG. 1—SNOW MELTING PIPES ON TERMINAL TRACK

Steam Supply— Since these heating and melting devices are in service only for short periods it is concluded that the most economical method of supplying them with steam is to place a spare locomotive on a sidetrack provided for the purpose and to connect this engine with the permanent steam supply main. A hydrant for water supply is placed adjacent to this track. To meet this requirement, several of the switching engines used in the terminal are equipped with special steam connections on the dome. A reducing valve is also fitted, so that with a boiler pressure of about 180 lb. the steam is delivered to the main at 15 lb. pressure. For the 67th St. junction, one locomotive will serve the surface radiators on the incline tracks, the coils at four switches and the coils in the several snow melting pits.

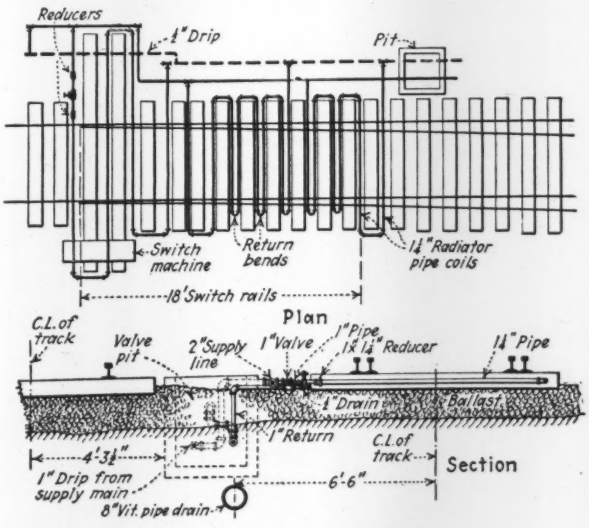


FIG. 2—STEAM PIPES AT SWITCHES

This snow protection service on the Illinoins Central R.R. has been worked out under the direction of D. J. Brumley, chief engineer of the company's Chicago

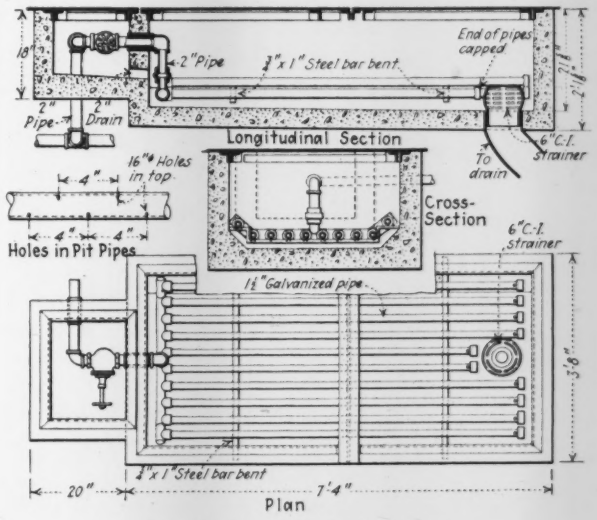


FIG. 3—SNOW MELTING PITS

Terminal Improvement organization, and C. H. Mottier, engineer of design. The permanent installation is being done by Chas. B. Johnson & Son, as general contractors.

Belmont Buys and Lays Concrete-Lined Pipe

The town of Belmont, Mass., has bought $60,000 worth of 6- to 12-in. concrete-lined cast-iron pipe for water-main extensions. The pipe will be laid by day labor. Charles W. Sherman is water commissioner of Belmont.

Heavy Sewer Construction Methods and Plant in Brooklyn

Wide Structures, Piles in Soft Bottom, Ground Water and Tide and Sewage Flow Call for Intensive Use of Machine Methods

MAIN sewers costing $10,000,000 are being constructed in Brooklyn Borough, New York City. Three of the operations typifying construction problems and conditions are the Wythe Ave. sewer, the Hamilton Ave. sewer, and the Flatbush relief sewer. These operations involve: (1) Outlet construction in tidal waters; (2) large structures—one-, two- and three-barrel conduits up to 50 ft. wide; (3) mud foundations requiring pile substructures; (4) deep trenching virtually usurping street widths; (5) tidewater backflow and seaward sewage flow to be managed during construction; and (6) wide, open cuts in sand flats carrying water. These conditions were met by mechanical equipment in large units. Indeed this work presents as notable an array of heavy construction equipment as is often found in sewer building.

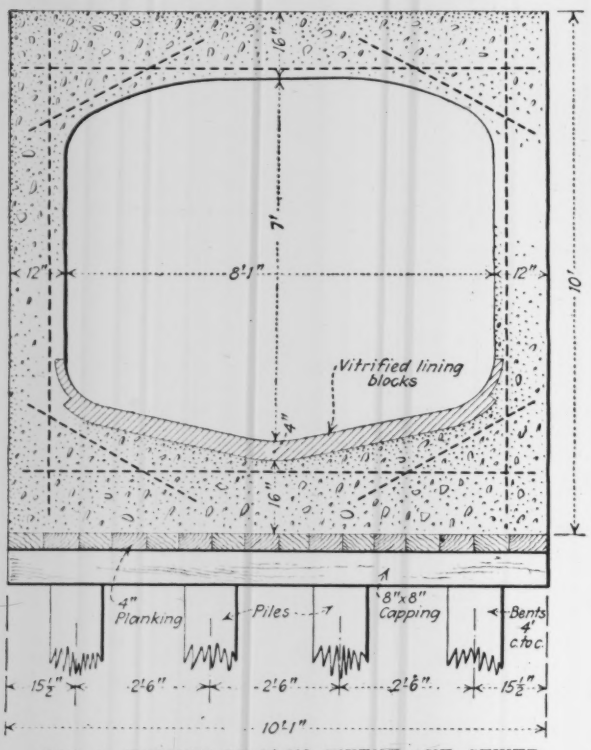


FIG. 1—SECTION OF 96-IN. WYTHE AVE. SEWER
This box section with saddle bottom invert is the type most frequently used but there are many variations, due to size and location, in the reinforcing and roof details.

All the sewers are 1:2:4 concrete with inverts lined, up to the flow line, with vitrified clay tile or lining blocks. The sections vary, but the most common is shown by Fig. 1, a box with saddle invert. It will be noted that it is heavily reinforced and requires invert lining. In the multiple-barrel sewers the partition walls are also heavily reinforced. In all but the few circular sections the outer sides, top and bottom are flat and so simplify formwork. Altogether the structure is representative of the modern concrete sewer structure as a construction problem. With these general points in mind the construction methods on three of the larger projects will now be considered in detail. The Flatbush relief sewer is an example of extremely large-scale construction in sand where water was the complicating factor. The Wythe Ave. sewer is constructed in mud, supported on a pile and plank foundation, subjected to tidal action and built in narrow streets. The important detail of the Hamilton Ave. sewer is its outlet which is through an overflow chamber constructed in a cofferdam in the East River.

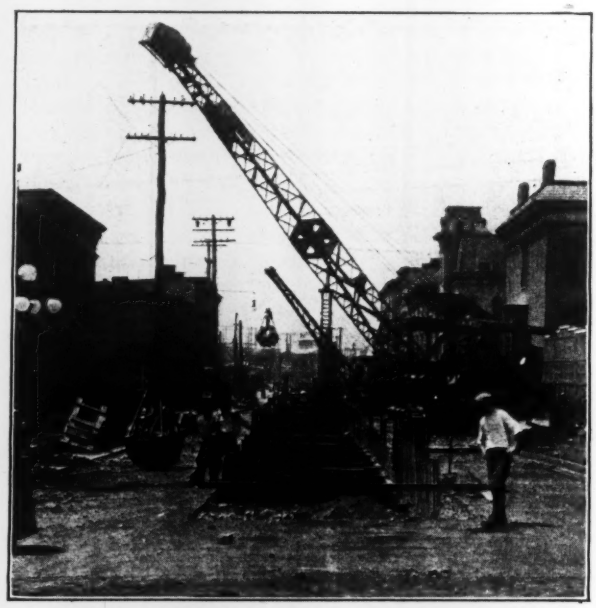


FIG. 2—CRAMPED CONSTRUCTION OPERATIONS ON WYTHE AVE.
Observe the heavy equipment, crawler cranes and clamshells making first and second cuts and piledriver following to put in pile substructure indicated in Fig. 1.

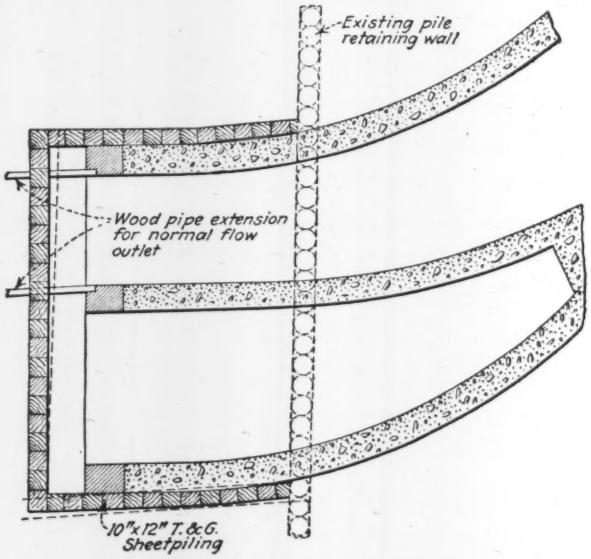


FIG. 3—COFFERDAM ARRANGEMENT FOR OVERFLOW CHAMBER

Wythe Avenue Sewer—This sewer is about 4,335 ft. long and ranges in size from 36 in. to 96 in. The cross-sections vary with the sizes, some are cylindrical, some are box with a saddle invert, Fig. 1, and others are box with a semi-circular invert. The three main construction problems were: (1) Operation in narrow streets, (2) handling sewage flow and reverse tidal flow, and (3) construction foundations. Those problems were developed mainly in the 78, 84 and 96-in. sewer, about 2,335 ft., which was virtually all below mean high water and subject to tidal flow with an new sewer was bulkheaded with sandbags and the outlet connection made. This bulkheading procedure has been used all along the new line to keep the tide waters away from construction operations. As fast as a length of new sewer is completed, it is bulkheaded and sewage turned into it. Where construction is in progress the sewage flow is bypassed in wood flumes.

All excavation has been by crawler cranes operating clamshell buckets. One crane works ahead, generally, in the center of the street, excavating from 8 to 10 ft. deep. The second crane follows working from the

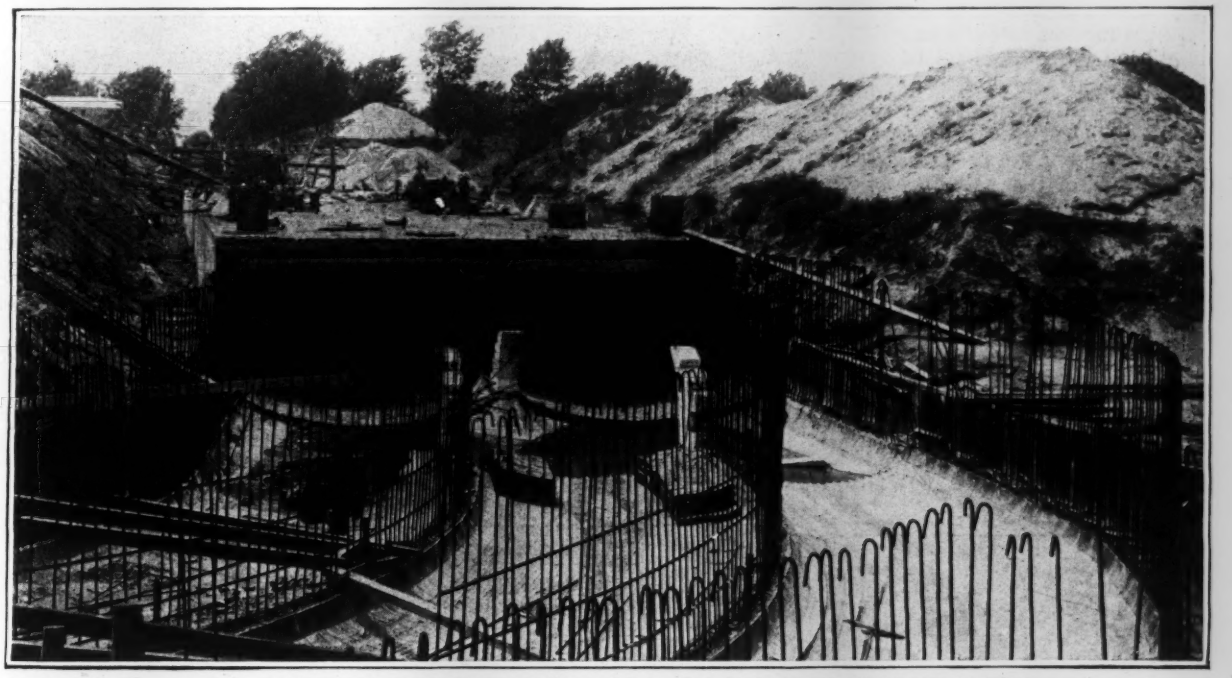


FIG. 4—TRANSITION FROM 198-IN. 2-BARREL SEWER TO 204-IN. 3-BARREL SEWER
Note the granite cut-waters in the transition chamber; also the standpipes on top of the completed sewer.

average range of 7½ ft. This sewer also replaced old sewer.

Construction was begun at the lower end where the 96-in. sewer empties into a 120-in. existing sewer to the river and therefore carried tidal flow, and was advanced up-grade. A considerable stretch of the new sewer was constructed before the connection was made so as to postpone taking care of the tidal currents that were operative in the old sewer. However, the new sewer is required to carry the daily flow of the old sewers that it replaces and its outlet into the 120-in. sewer was soon urgent. The completed section of the

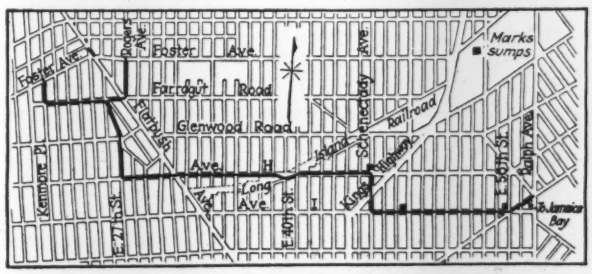


FIG. 5—MAP OF FLATBUSH RELIEF SEWER
This three-mile sewer ranging from 4 ft. to 18 ft. equivalent circular section is one of the largest under way in any city and will cost about a million dollars a mile.

side of the ditch and excavating to grade. All spoil is loaded into motor trucks and hauled back to completed sewer where it is used for backfill. The space for construction operations, noted in Fig. 2, is barely enough to provide room for the crane crawlers. Overhead wires all had to be removed to give headroom for the booms and overhanging trees caused difficulty and necessitated care. Sheeting is hand driven and it and all possible bracing are left in the ditch as the backfill settles to its final position. This sheeting is used for the outside wall of the invert form and also for the vertical wall form in the sections where one is required.

It has been necessary to support most of the 96-in. and 84-in. sewer and certain portions of the smaller sections on pile foundations, Fig. 1. Where piling has not been considered necessary, the city's engineers have required a gravel foundation. The mud is dug out to approximately 10 in. below grade and the trench filled with gravel. Where exceptionally swift currents are encountered large stones are placed first and covered with the gravel.

Concrete is mixed in small mixers in the street and chuted into place. The invert is poured on the foundation planking or gravel base as the case may be. Wooden forms are used and no specific lengths are poured in any one operation, this being governed by the amount

of grade ready for concrete. After placing the tile lining, the arch is poured and allowed to stand in the forms for 48 hours.

Hamilton Avenue Sewer—This work resembles that on Wythe Avenue. The different feature is the overflow chamber at the river end. Here an 84-in. section widens out to a 19-ft. section (Fig. 3) and extends out into the river at a point where the water front has been in use over a hundred years. This ancient use introduced the main construction difficulties. In intermittent efforts to stabilize the river bank and provide a firm footing for buildings and streets log mats made up of alternate cross layers of 16 to 20-in. logs had been sunk by means of heavy stones and covered a considerable area, including all of that to be occupied by the overflow chamber. The cumulative layers of these mats had reached a thickness of about 30 ft.

The foundation piles were first driven. Considerable difficulty was experienced in penetrating the 30 ft. of logs and rocks, but this was finally accomplished by putting steel points on the piles. After all of the supporting piles had been driven the cofferdam was built as shown in Fig. 3. An existing pile retaining wall crossed the site of the overflow chamber. A row of sheeting was driven about a foot in front of this retaining wall and by filling the intervening space with earth an effective water seal was made for the upper end of the cofferdam. The sides and the front end were made of 10x12-in. tongue-and-groove sheetpiling in about 40-ft. lengths. Not so much trouble was experienced in driving this piling as in driving the bearing piles because of its much greater weight. The cofferdam, as shown in Fig. 3, was left in, the front wall being cut off flush with the top of the invert, to prevent scour beneath the overflow chamber structure.

For construction purposes the contractor extended the sides and drove another row of sheetpiling several feet outside of the one shown in Fig. 3. This gave room for placing the granite portal, cutting off to grade the front wall of sheetpiling and other necessary work; it also provided space for three 2,500-g.p.m. suction pumps that were used to unwater the cofferdam. This outside row of sheetpiling was pulled, with considerable difficulty, by reversing an ordinary steam pile hammer. The first length required 8 hours continuous jarring before moving the first ¼ in. This operation was described in detail in *Engineering News-Record*, Feb. 11, 1926, p. 248.

FIG. 7—FLATBUSH RELIEF SEWER IN THE BUILT-UP PART OF THE CITY
Note the two rows of sheeting, the inside row being used for the outside of the wall form.

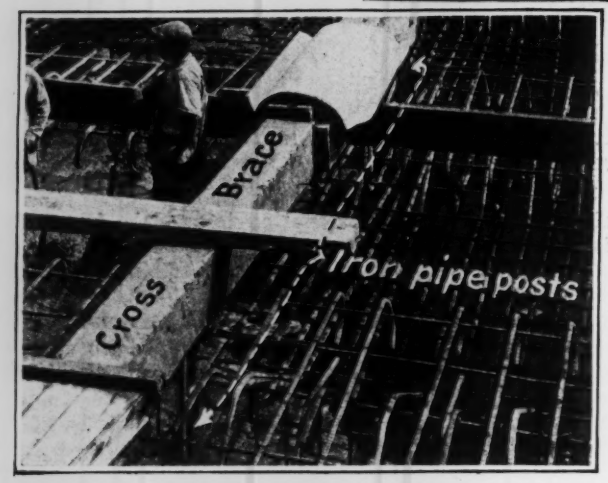


FIG. 6—CONCRETING ROOF OF 3-BARREL SEWER
The pipe posts left in the division walls are finally grouted full and cut off flush with the top of the sewer.

No trouble was experienced in pouring the overflow chamber by chuting the concrete from mixers operating on the adjacent dock. After completing the work within the cofferdam, there remained about 10 ft. of the chamber to be completed to connect with the end of the sewer. Sheetpiling was driven on the sides back from the existing pile retaining walls to the end of the completed sewer. It was found, however, that no amount of pumping could keep the water from boiling up into this second cofferdam. It was finally sealed by placing a false bottom of alumina cement to a depth of 18 in. Divers cut off the piles to this necessary depth. After allowing the false bottom to set for 24 hours, the concreting of the overflow chamber was completed.

Flatbush Relief Sewer—This outfall sewer shown by Fig. 5 is the largest of the new sewers. There are more than 3 miles composed of single-, double- and triple-barrel sections and ranging in size from 216 in. to 48 in. All is box section as shown in Fig. 4. In general no departure was made from conventional design. Construction procedure has differed somewhat on the different parts of the project because of the various sizes of sewer and because ground water conditions and the number and character of buildings have been radically dissimilar at different points. Soil con-

ditions on the other hand have been practically uniform —a loam about 3 ft. thick underlain by good quality sand. In fact, on a majority of the work this sand has been used in the concrete.

The most notable feature of the work, other than the size of the sewer, and the handling of ground water, is the elaborate mechanical plant of the contractor. Steam shovels and crawler cranes operating clamshell buckets and draglines perform the excavation; sheeting is mostly driven by air hammers operated by portable compressors; crawler-mounted concrete mixers are charged from small trucks that have previously been loaded by bucket elevator loaders at the material piles; a large fleet of trucks is used in the excavating and backfilling operations; various sizes and types of pumps are in use and an ingenious hydraulically operated machine for bending reinforcing steel is proving satisfactory and economical.

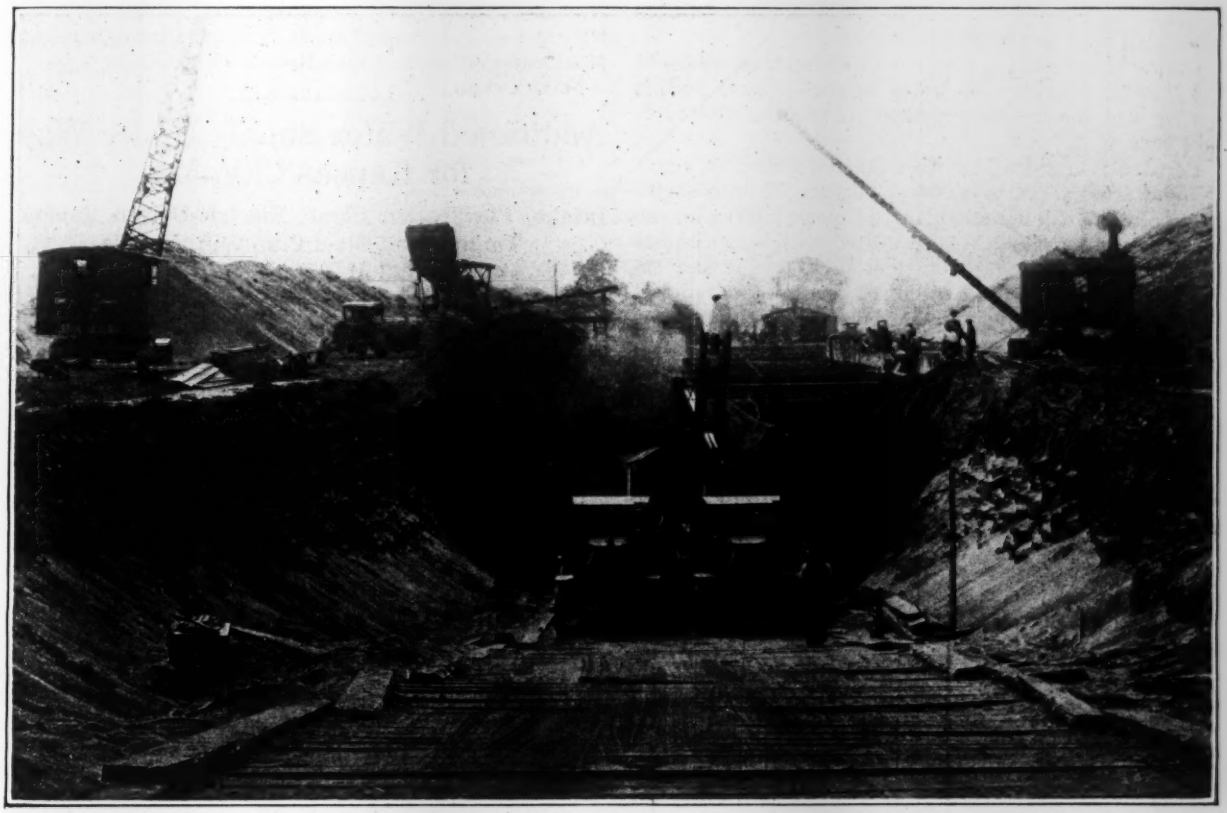


FIG. 8—CONSTRUCTION OPERATIONS IN OPEN TERRITORY
This indicates well the extensive plant of large equipment units where the cut was through the sand flats toward Jamaica Bay and much water had often to be handled.

It is possible to divide the construction work on the whole sewer project into two parts—that in the built-up part of the city and that on the flat undeveloped land toward Jamaica Bay. The number of lineal feet of sewer is divided rather equally between these two parts of the project although most of the large sewer of two and three barrels is located at the lower end toward the bay. It so happens also that sub-surface water conditions were found in their opposite extremes on these two parts of the work; practically no water was encountered in the upper line of the sewer through the built-up section while special efforts had to be made to cope with it on the lower sandy flats.

In the built-up section steam shovels excavate as deeply as possible without sheeting and bracing. The trench is then sheeted and cranes with clamshells go down to subgrade. The maximum width of ditch is 30 ft. and the deepest cut is 28 ft. Fig. 7 shows the sheeting. Two lengths are usually necessary. The upper length is 8 in. outside of the lower length which is driven to grade and is used as the outside of the form for the side walls. The lowest brace is placed just above the invert and is removed as soon as the invert is poured. Posts are placed under the cross-braces on the division walls of multi-barrel sewer, none are necessary on the single-barrel type. These are wrought pipes which are concreted into the division walls. They extend above the completed roof, Fig. 6, and are finally grouted full and cut off flush with the top of the sewer. All sheeting is left in the ditch after backfilling.

The concrete mixers, from ½ to 1 cu.yd. are crawler-mounted and operate on the ditch-bank, chuting the concrete to the forms below. Materials are brought to the mixer in small batch trucks operating from the material piles, placed in unused side streets to give least interference to cross traffic and construction operations. Elevating bucket loaders equipped with measuring hoppers load both the sand and gravel. Cement is in some cases added at the material piles and in others at the mixer skip.

The invert is poured on subgrade, practically no foundation planking being required on the compact sand base. Bulkheads cut to cross-section are placed at about 40-ft. intervals and support the reinforcing steel. Side

forms built to a 1-ft. radius are the only other invert forms used. The wall forms are next poured followed by the arch forms. These are wooden forms carried on a wooden traveler operating on rails placed on the invert. Arch forms are required to stand 3 days while 24 hours is regarded sufficient for the others.

Backfilling is not allowed for 30 days although in hot weather a curing layer of wet sand is placed on the completed barrels. All reinforcing steel is bent to fit at a central bending shop. Here a hydraulically operated machine designed by one of the contractor's men has been installed with a great saving in time and cost over hand methods. This machine was described in detail in *Engineering News-Record*, Dec. 31, 1925, p. 1082. As much as 25 tons of double-truss 1-in. bars have been bent and hooked in 8 hours.

On the lower end the sewer runs through undeveloped flat lands. Considerable water is encountered in this section and construction methods have been altered to take care of it.

Construction operations were started where the sewer changes from a 198 to a 204-in. section. Fig. 4 shows this point at a later stage in the work. Here an extensive sand pit which was saturated with water had to be traversed. A sump was sunk below grade and excavation by dragline was made for several hundred feet each way. Concreting was then begun at the ends of these excavations, working back toward the corner, the water being forced ahead of the construction work into the sump from which it was pumped out onto the surrounding flat lands. Test borings showed that the water table was pulled down considerably by the pumps. Following the pouring of the sewer in the sand pit concreting was continued down grade on the 204-in. and up grade on the 198-in. sewer. A portable pump discharging through a pipe into the sump in the sand pit was moved ahead of the construction operations moving down grade and kept the subgrade unwatered. This method, however, did not prove as effective as working upgrade.

At a second starting point excavation is carried upgrade followed by the concreting. The trench is dug and sheeted about 4 ft. wider than the outside width of the sewer (51 ft. for the 216-in. sewer which was 47 ft. wide), thus providing a 2-ft. channel on each side of the completed sewer. These channels carry the water past the finished work to the sump. In constructing these channels sheeting 3 ft. long is driven flush to grade 2 ft. inside of the ditch wall sheeting. The channel is excavated approximately 1 ft. below grade and refilled with stone to prevent scour. The wooden invert form is then placed and poured usually in 30-ft. sections. At the end of each concreted section, a transverse channel similar to the side channels but 3 ft. wide is constructed. In effect gravel channels either 2 or 3 ft. wide and 1 ft. deep are placed at all exposed faces of concrete to prevent scour. This method of bypassing the water around the construction work is proving very successful. When operations had proceeded a considerable distance from the first sump a second one was sunk. The sand base so far has been very compact and no pile foundations have been necessary.

Construction work on the lower end has been on a somewhat larger scale than on the upper end. Steam shovels excavate about half of the total depth of ditch which is a maximum of 25 ft. The shovels discharge into motor trucks entering the ditch on ramps which are moved ahead about 200 ft. at a time. As soon as the sheeting and bracing are placed, cranes operating clamshells excavate to grade. Since the ditches on this section of the sewer are wide, in some cases over 50 ft., crawler cranes operating on both sides of the ditch have been used. The excavated material has been dumped along the bank of the ditch directly from the excavating buckets instead of being loaded into trucks and carried back for backfill. Fig. 8 is a view of the work on this section showing these operations.

Direction—The work described has been under the direction of the Brooklyn Bureau of Sewers, Arthur J. Griffin, chief engineer. The contractors are: Wythe Ave. sewer, D. Bonnaci, Brooklyn, N. Y.; Hamilton Ave., Necaro Co., Inc., Brooklyn, N. Y.; and Flatbush relief, Montrose Contracting Co., New York City.

Additional Water Supply Under Way for Kansas City, Mo.

Intake, Purification Plant, Electric-Driven Pumps, Tunnels and Steel Pipe Will Provide 125 M.G.D. Supply

THE following general description of the water-works system that is being built for Kansas City, Mo., is given primarily as a background for later construction articles in one of the largest water-works projects now under way. These works will provide 100 (average) to 125 m.g.d., increasing the present supply by about 50 per cent and are designed to carry the city until at least 1942. They will deliver filtered and chlorinated Missouri River water into the present distributing system by connections with the existing Turkey Creek station and reservoir, the Northeast storage reservoir, and the Holly St. reservoir.

Construction is now under way on: (1) Intake and purification works, North Kansas City, Mo.; (2) Missouri Valley tunnel to carry the new supply from the purification works to an uptake shaft on the bank of the Missouri River in Kansas City, Mo.; (3) East Bottoms gravity steel conduit of 48 m.g.d. capacity from this uptake shaft to the new East Bottoms high-pressure station; (4) Turkey Creek tunnel to carry the remaining 112 m.g.d. from the Missouri Valley tunnel to the present Turkey Creek pumping station; (5) East Bottoms pumping station and 17-m.g. covered equalizing reservoir.

The intake is a 52x35-ft. mass concrete crib supported on timber piles. Its minimum capacity is 150 m.g.d. Standard willow fascine mattress and rock paving protect the intake structure from damage by the river and also maintain a channel in front of it. Four 38-in. welded steel suction pipes 150 ft. long connect the intake and the low-lift pumping station, a reinforced-concrete substructure and brick masonry and steel superstructure 102x36 ft. in plan. Its capacity is 140 m.g.d. The pumps discharge through two 60-in. steel pipe lines resting on concrete cradles into four preliminary settling tanks with reinforced-concrete walls on piles of the same material. Each tank is 200 ft. in diameter, has a capacity of about 4 m.g.d. and is equipped with revolving clarifiers. The water enters each tank through a baffled influent weir and is discharged through an effluent weir, each located at the top

and on the circumference of the tank. The tanks are expected to reduce the suspended matter 90 per cent.

After preliminary sedimentation the water goes to two 1-m.g. mixing tanks 90 ft. in diameter, of reinforced concrete on a concrete pile foundation. The main application of lime is effected here, provision however being made for application at the preliminary tanks when necessary. The first application of alum is also made at the mixing tanks, provision being made for a second application in the final settling basins. Mixing is effected by introducing the water into the tanks tangentially at the circumference and withdrawing it at the center of the bottom. The chemical building, located just west of the mixing tanks, is 150x45 ft. in plan, with a reinforced-concrete substructure and a brick and steel superstructure. Storage for lime and alum is provided to take care of over two weeks' continuous peak operation. Arrangement is made here for the manufacture of alum. In the chemical building is also located the central heating plant which heats the purification works. The intake and low lift station are heated electrically.

The water passes from the mixing tanks through three reinforced-concrete conduits and twenty-seven 30x30-in. sluice gates to the coagulating basins which have a total capacity of 37½ m.g. and are each 333 ft. long by 309 ft. wide by 18 ft. deep. Facilities are provided for continuous sludge removal, if that is found to be desirable. The coagulated water is discharged over a weir into the final settling basins. Gates are also provided about 4 ft. below the weir to take advantage of this storage in case of an emergency. The two final settling basins, having a total capacity of 14½ m.g., are each 359x254 ft. in plan and 17 ft. deep, and discharge into the filters through a concrete conduit.

The filters are of reinforced concrete, 200x250 ft. in plan over all. The twenty-four 4-m.g. filter units have 27 in. of sand and 18 in. of gravel. Wash-water is stored in two 75,000-gal. steel tanks, supplied by three 2,500-g.p.m. centrifugal pumps located in the secondary pumping station. Water for general plant purposes is supplied at 80-lb. pressure from a 75,000-gal. steel tank on a 120-ft. tower, located on a hill north of the purification works. This tank is fed by two 250- and two 500-g.p.m. pumps located in the secondary pumping station.

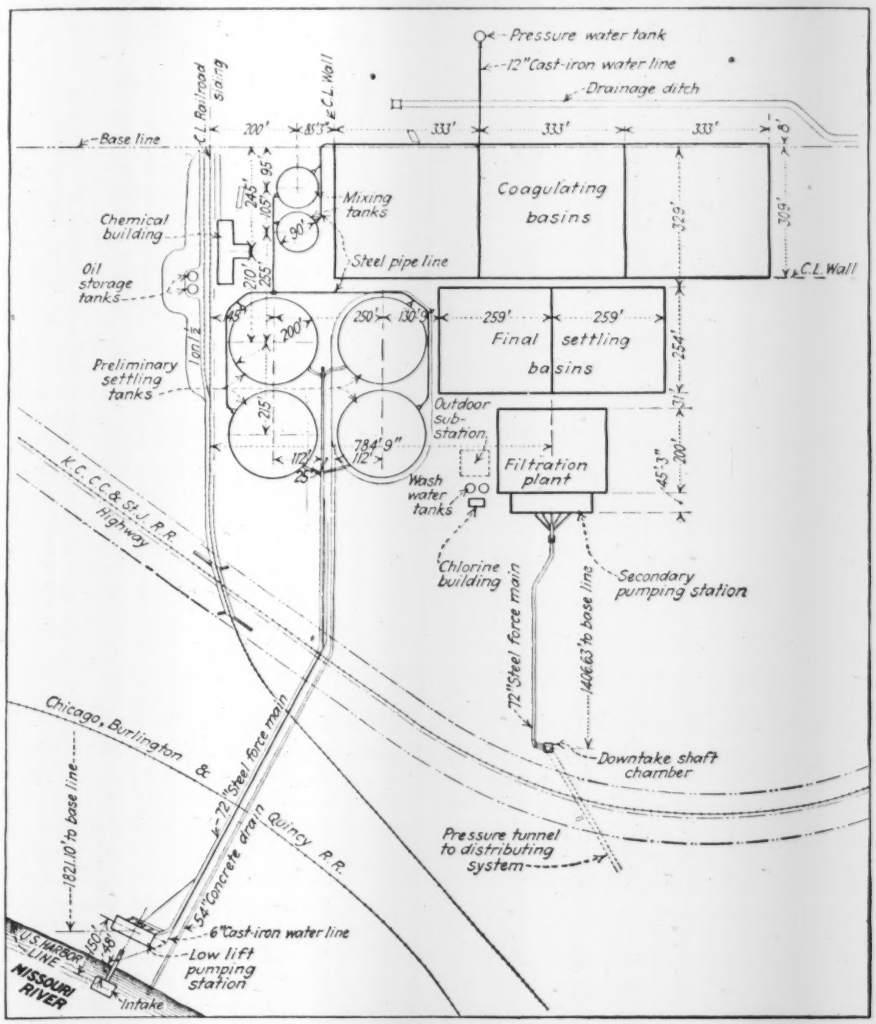


FIG. 1—LAYOUT OF NEW PUMPING AND PURIFICATION PLANT FOR WATER-WORKS OF KANSAS CITY, MO.

Missouri River water will be passed in succession through preliminary settling tanks, mixing tanks, coagulating basins, final settling basins and filters, be chlorinated and then be delivered into the present distributing system. Low-lift pumps supply water to purification plant. Secondary pumps at the secondary pumping station deliver water through a short run of steel conduit into a pressure tunnel beneath Missouri River Bottoms, from which 30 per cent goes to the new high-service pumping station and 70 per cent through a tunnel beneath Turkey Creek Bottoms to the existing Turkey Creek reservoir and high pressure station.

The chlorinating apparatus with a maximum capacity of 600 lb. in 24 hr., is housed in a 35x21-ft. reinforced-concrete building.

The secondary pumping station is 165x46 ft. in plan and has a capacity of 140 m.g.d. The pumps discharge through a header system into a 72-in. steel pipe line about 500 ft. long leading to the downtake shaft of the Missouri Valley tunnel, which is 10 ft. in diameter and 280 ft. deep, entirely lined with concrete. The tunnel is 7½ ft. in diameter and 15,500 ft. long, driven on a level grade and on a tangent to the uptake shaft located in Kansas City, Mo. It was necessary to drive the tunnel at this depth since suitable rock formation was not found at a higher elevation. The minimum capacity of the tunnel is 160 m.g.d. From the uptake shaft of this tunnel, 30 per cent of the water goes to the new East Bottoms pumping station and 70 per cent passes through the Turkey Creek tunnel to the Turkey Creek reservoir.

The Turkey Creek tunnel downtake shaft is located

50 ft. west of the Missouri Valley tunnel uptake shaft. It is 8 ft. in diameter and 140 ft. deep. The Turkey Creek tunnel is 6 ft. in diameter and 11,000 ft. long, driven in rock and lined with concrete. It is on a level grade, at El. —110. The water rises at an uptake shaft at the end of this tunnel and discharges through a 66-in. steel pipe line about 350 ft. long into the Turkey Creek reservoir. The East Bottoms gravity conduit from the Missouri Valley uptake shaft is a 54-in. steel pipe line, about 15,000 ft. long, discharging at the new East Bottoms pumping station into the new 17-m.g. covered

FIG. 2—PARTLY COMPLETED PRELIMINARY SETTLING TANKS

Each of the four tanks (one not shown) has an influent and an effluent channel-weir opposite each other—seen most clearly by the influent weir on the nearest tank.

equalizing reservoir, which is 380x345 ft. in plan and 18 ft. deep. The East Bottoms pumping station is 52x92 ft. in plan, not including a 50x28-ft. switch house. Two of the proposed 24-m.g.d. motor-driven centrifugal pumps will be installed at first. The pumps discharge into the city distribution system through a 42-in. steel line about 6,000 ft. long.

It has been possible to equip the entire new water-supply system for electrical operation since a very favorable contract was made for the purchase of current.

Test Corn Cobs as Trickling Filter Medium

Recently in Illinois when corn conferences were being held in different parts of the state, the president of the University of Illinois requested information as to all kinds of research going on in the university which had a bearing on the question of utilization of corn or its by-products. It happened that an experimental sewage trickling filter using corn cobs instead of stone had just been built. Dr. A. M. Buswell, chief of the State Water Survey Division, states that the corn cobs will work but there is a serious question as to how long they will stand up. Possibly the frequent replacement of the cobs might offset their low first cost. A number of farmers have indicated that corn cobs under water rot very slowly, one mentioning that he had found corn cobs in good condition after having been wet thoroughly for twelve years. It is also suggested that corn stalks, which have comparatively little value, may also be used in filters. Experiments with straw as a filter medium have been made in England. Both cobs and stalks may absorb sufficient nitrogenous matter from the sewage and become softened so as to be valuable as a fertilizer but the investigation has not yet proceeded far enough to show whether or not the substitution of corn stalks or cobs in place of crushed rock for filter use will be practicable.

Progress on the Experimental Arch Dam

Records of Deformation, Deflection and Temperature to Be Made by Two or More Independent Means—Work Now Under Way

WORK has started at the site on Stevenson Creek, Calif., selected for the experimental dam that is being built by Engineering Foundation's committee on arch dam investigation. By the middle of February excavation for the foundation had been completed and all materials for building this structure were on the ground. The committee meantime had been completing plans for the devices and methods to be used in measurements and tests. Previous reference to plans for this test appeared in *Engineering News-Record*, Sept. 24, 1925, p. 510, since when the program has been developed materially.

Three main values will be measured: deflection, deformation or strain, and temperature. In each case at least two independent methods are to be used.

The deflection measurements will be made from five steel towers, 5 ft. square and extending to the full height of the dam, located on the downstream side, each surrounded by a wooden shelter to protect it from wind and unequal temperature stresses. The towers will be located at the center and 20 and 40 ft. to either side. At 5-ft. vertical intervals invar distance pieces will extend from each tower to the dam whereby the variations in this distance or, in other words, the deflection can be measured by electrical means at a central point remote from the structure.

To check deflection measurements a special clinometer will be used to measure variations in deflection between reference points that are likewise spaced at 5-ft. vertical intervals. This device consists essentially of a vertical shaft supporting a sensitive level-bubble (about 4½ sec. of arc) brought to a truly vertical position by a standard Starrett micrometer head. A third deflection measurement will be made with the use of theodolites.

Deformation is to be measured by 150 Bureau of Standards carbon-disk electric telemeters buried in the concrete of the structure. Their resistance, which will be read at a central station, will give an index of the strain in the concrete at the telemeter location. For a check, strains will be measured by a specially designed strain on a large number of octagon figures on the downstream surface of the dam, located generally at 10-ft. intervals horizontally and vertically. Corresponding measurements are to be made on the upstream face of the dam when the water is low enough.

Temperature measurements are to be made with a coil of wire which will provide an electrical index of the temperature at each telemeter location. As a check, direct readings of temperature will be taken.

Special care is being taken to secure uniformity of concrete, both in regard to the various sizes of aggregate used and in uniformity of water-cement ratio as well as in time of mixing. In addition to specimens made to be tested at 7 days, 28 days and at some longer period, specimens will also be retained for test at the time of actual failure of the dam. Test specimens for the determination of characteristics other than strength will be sent to testing laboratories at the University of California.

The project is sponsored by Engineering Foundation (Alfred D. Flinn, director), and the work is in the hands of the Committee of Arch Dam Investigation (Prof. Charles D. Marx, chairman). The sub-committee having immediate charge of the construction and tests is headed by Harry Hawgood, consulting engineer, as chairman. The experiment has been made possible through the generous financial co-operation of a large number of interested companies and by the Los Angeles County Flood Control District. The committee is desirous of receiving constructive criticism of its program, and any such communications should be sent to H. Hawgood, 722 H. W. Hellman Building, Los Angeles.

Discuss Better Specifications for Metals and Textiles

A.S.T.M. Committees Meet at Providence—Study of Sulphur in Rivet Steel—Much Joint Standardization

AT a group convention of the American Society for Testing Materials held last week at Providence, much new work was discussed by various committees, including those on metals and textiles. The increasing requirements of modern technology are responsible for much of this current work, especially in the metals committees. Other phases represent intersociety co-operation in joint standard specifications, in which field considerable progress was made during the past year, and experimental study of materials and tests.

Hard-drawn copper wire specifications are under discussion with representatives of various consuming interests, and the adoption of a single American standard is expected in the near future. It now seems probable that agreement on a single specification will shortly be reached. In the general field of non-ferrous metals and alloys, new specifications have been drafted for steam metal, aluminum bronze, and some related materials, which will probably be laid before the society next June. Silver solders are to be taken up shortly.

Sulphur in steel has for several years been the object of one of the most interesting studies in the steel field. The Joint Committee on Phosphorus and Sulphur in Steel has already published the results of its tests on rivet steel and structural steel with varying sulphur content (0.03 to 0.18 and 0.08 per cent respectively), and has now reached the point of formulating conclusions concerning rivet steel. In this material the test results have shown no influence whatever of sulphur content up to the maximum amount tested, except for a relatively slight decrease in Charpy (notched-bar) impact resistance and a very slight reduction of endurance. Sulphur tests on forging steel are in progress, while those on spring steel contemplated in the original program may be abandoned. Tests on rail and tire steel remain to be carried out. Work on phosphorus may begin soon.

Research on the effect of high temperatures on the properties of metals is now in the stage of test of materials by various laboratories in accordance with a carefully devised schedule of tests. Steel forgings are being subjected to tests to determine the influence of greater or less reduction in the press or under the hammer. Wrought iron is also the subject of research; the effect of phosphorus in staybolt iron and the effects of annealing are now under study. Results so far indicate that annealing improves both plain and threaded bars. In the field of non-ferrous screen wire cloth, large-scale exposure tests have been started. Iron and steel coated with different metallic protective coatings are involved in another elaborate series of exposure tests. Pending the results of these tests, the corrosion committee is working out specifications for certain coated materials, among them galvanized wire and fencing. In co-operation with Lloyds it has undertaken corrosion tests of riveted members of wrought iron and steel. Another committee is making a thorough test comparison of corrosion tests for non-ferrous metals.

An interesting study of test methods is being made in connection with thin sheet metal, both ferrous and non-ferrous, where forms of test specimens vary widely. Tests have been started to compare them.

Steel for railway service has been under discussion for the past year with a view to harmonizing the society's specifications with those of railway organizations. The A.R.E.A. specifications for rails, tie plates and spikes have been taken over, with minor change; the drop test of rails was changed, however, by requiring the rail to be tested with head up instead of base up. Girder rail specifications were similarly harmonized with the American Electric Railway Association. On the other hand, a proposal to follow the American Railway Association in combining the specifications for locomotive and car structural steel failed. Discussion of higher-strength steel for bridges and buildings led to no action. In the field of automobile springs, where the Society of Automotive Engineers is active, the committee will recommend (for the second time) that the A.S.T.M. discontinue work. A co-operative specification for marine boiler steel has been drawn up.

Activity in steel pipes and tubes is concerned on one hand with raising test requirements to assure higher quality, and on the other hand with establishing specifications for common or low-grade pipe. Higher test requirements were adopted for pipe for special service, including flanging and coiling, and the decision was reached to draft new specifications for ordinary types. Separate study is being given to the subject from the viewpoint of high-temperature service, and a specification for this grade was also drafted and discussed on a tentative basis. The wrought-iron committee also has in view a specification for high-temperature and high-pressure pipe. Specifications for high-temperature forged steel flanges are to be presented to the society. Materials for 1,000 deg. and 1,200 deg. F. service are next to be taken up.

Five years' work on the development of a specification for cold-rolled strip steel resulted in the presentation and approval of a specification. After about the same length of time a specification for shafting has been worked out, as part of a co-operative enterprise with several other societies; bar steels are to be grouped in two classes (hot-rolled and cold-finished, the latter including shafting) instead of three as heretofore.

Specification work is fully as active, though not as far advanced, in insulating materials and in textiles. The work on rubber remains largely occupied with discussion of performance tests.

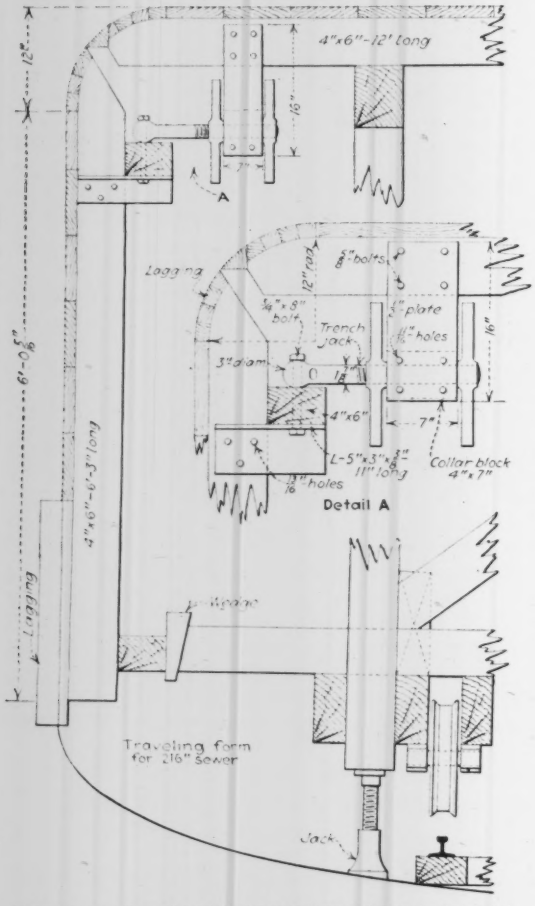
Study of paint is now occupied mainly with accelerated tests for weather-resistance and with a spectrophotometric analysis and description of color, which promises to be highly successful. The new type of lacquers is also under study.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Trench Jacks Used to Center Wooden Forms on Large Sewer Job

FOR rapidly centering the wooden forms for the side and arch of the Flatbush Ave. sewer, a $3,250,000 reinforced-concrete project in Brooklyn, N. Y., the contractor has devised an adjusting mechanism made from an ordinary trench jack. The position and arrangement of the jack are shown in the accompanying illustration. The forms are built in about 30-ft. sections, the vertical part of the sides of the forms being



DETAILS OF APPLICATION OF TRENCH JACKS IN FORMWORK CENTERING

adjusted by the trench jack and the top of the form being raised and lowered by jacks in the usual manner. The curved fillet at the top is made up of a hinged sector of a circle and lagging as shown. The wall form is set in place and wedged to an approximate position at the bottom. The jack at the top then plumbs the wall and brings it to exact position.

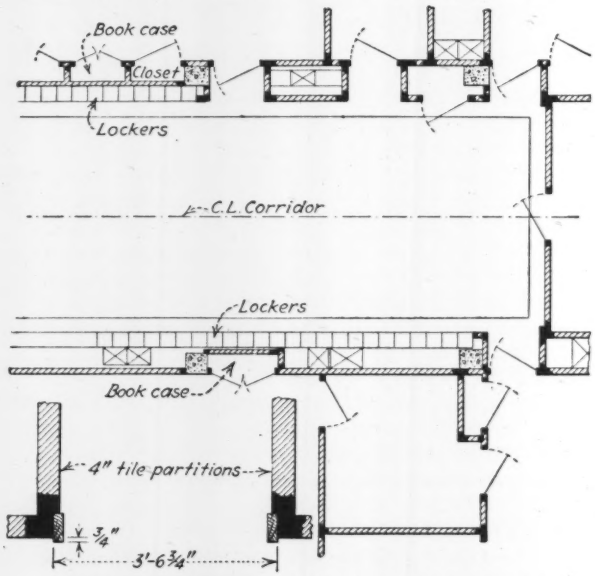
An ordinary trench jack is used, the shoe being removed and a hole drilled through the bulb end as shown. A ¾-in. bolt passing through this bulb end and through a 4x6 running longitudinally along the wall forms makes the necessary connection to the form. This bolt prevents the screw from turning so that any movement of the handle of the jack is transmitted directly to the wall form. A wooden collar is placed around the screw between the handles. Hangers consisting of two ½-in. steel plates 16x7 in. in size are bolted to each side of this collar and to the 4x6 beam holding the roof flooring.

This mechanism has proved very successful; after a little practice the operators wedged the bottoms quite closely to exact position and a few turns of the handle of the trench jack completed the centering process. The contractor using this device is the Montrose Contracting Co., New York City. Several sizes of forms were used on the job, the one shown in the illustration being for a sewer of box section approximately 14x9 ft.

Expediting Laying Up Tile Partitions

BY NELSON L. PROTHEROE
Denver, Colo.

THE new South High School at Denver, Colo., required 600 door bucks in a total partition area of 150,000 sq.ft. To avoid duplication of work and layout by the bricklayer foreman after the rough bucks were



TYPICAL PARTITION LAYOUT OF DENVER SCHOOL
Heavy black shows where painting for tile partitions was done on slab.

set by the carpenters, the men setting the bucks painted on the rough concrete slab the exact locations where the partitions were to run.

Owing to the somewhat complicated arrangement of interior partitions it was at first thought that one foreman wih two or three journeymen only could economically handle the work. Yet, when bad weather broke

upon the brick masons on the outside walls, a whole force of twenty was thrown in on partitions. Being guided by the black marks but very few errors were made in laying up.

Accurate Equipment Performance Data Kept by Georgia Highway Department

By W. R. Neel
State Highway Engineer, East Point, Georgia

In order to have accurate information regarding the cost of operation and the performance of various types of equipment used on maintenance work, performed by the Georgia State Highway Department, a daily record is made on each piece of motor equipment, showing gasoline, oil and grease consumption and cost; repairs, parts and labor cost; miles traveled, actually working and light travel, together with weather conditions. These reports are prepared by field men in charge of the operation of the equipment, checked and typed monthly by division offices and forwarded to headquarters on the form shown below.

Thus we take the record on one 5-ton crawler type tractor, motor No. 4154 which during one month was operated 19 days, consuming 260 gal. of gasoline at a cost of $44.20, 60 qt. of oil at $9.90 and 42 lb. grease

STATE HIGHWAY DEPARTMENT OF GEORGIA
OPERATION COST OF EQUIPMENT

PATROLMAN_____ OPERATOR_____ TAG NUMBER_____ YEARS OPERATED_____ DIVISION NO._____ MONTH ENDING_____ 192_

COUNTY_____ NAME OF EQUIPMENT_____ MOTOR NUMBER 4154 SERIAL NUMBER_____

DATE	GASOLINE GALS.	GASOLINE COST	OIL QTS.	OIL COST	GREASE LBS.	GREASE COST	REPAIRS OUTSIDE SHOPS	REPAIRS HIGHWAY SHOP	TIRES PARTS MATERIAL	LABOR CHARGES	TOTAL COST	MILES AND HOURS WORKING MILES	WORKING HOURS	LIGHT TRAVEL MILES	LIGHT TRAVEL HOURS	RATE WET	RATE DRY	STATE ROUTE NUMBER AND BETWEEN WHAT TOWNS	NATURE OF WORK PERFORMED	EQUIPMENT USED WITH (NAME AND SERIAL NO.)
1																				
2																				
3	15	2 55	20	3 30	6	48					6 33	12	8			✓			MACHINING	1-8½' GRADER
4	20	3 40									3 40	12	10			✓			"	"
5	20	3 40									3 40	7	5	10	5	✓			"	"
6	15	2 55									2 55	8	4	1	1	✓			"	"
7												4	3			✓			"	"
8	10	1 70									1 70	8	4			✓			"	"
9																				
10																				
11	20	3 40			4	32					3 72	6	3			✓			"	"
12																				
13	10	1 70	20	3 30							5 00	10	5			✓	✓		"	"
14												4	3			✓			"	"
15	10	1 70									1 70	10	5			✓			"	"
16																				
17																				
18	15	2 55									2 55	2	1	12	6	✓			"	"
19	20	3 40									3 40	12	10			✓			"	"
20	20	3 40			8	64					4 04	10	8	2	1	✓			"	"
21	20	3 40									3 40	12	10			✓			"	"
22	20	3 40			10	80					4 20	14	8			✓			"	"
23																				
24	15	2 55									2 55	14	9			✓			"	2-8½' GRADERS
25	15	2 55									2 55	18	10			✓			"	"
26	15	2 55			4	32					2 87	16	10			✓			"	"
27																				
28			20	3 30	10	80					4 10	4	2			✓			"	"
29																				
30																				
31																				
ENTER ON THIS LINE ALL NO. NOT LISTED ABOVE TOTALS	260	44 20	60	9 90	42	3 36					57 46	183	118	25	13	17	2			

IF EQUIPMENT IDLE STATE CAUSE ON EACH DAY ABOVE.
SHOW DATES OIL CHANGED 3RD - 18TH - 29TH.

COST PER MILE 0.279

IN COLUMN "NATURE OF WORK PERFORMED" SHOW OPERATIONS AS "GRADING, GRADING AND DITCHING," "HAULING OR LIGHT TRAVEL."
IN COLUMN "STATE ROUTE NUMBER," SHOW DIRECTION FROM SECTION HEADQUARTERS AND ROUTE NO., VIZ: NO. 3 NORTH.

FIG. 1—DATA ON MONTH'S PERFORMANCE OF 5-TON CRAWLER TRACTOR

STATE HIGHWAY DEPARTMENT OF GEORGIA
OPERATION COST OF EQUIPMENT

PATROLMAN_____ OPERATOR_____ TAG NUMBER_____ YEARS OPERATED 19 MOS DIVISION NO._____ MONTH ENDING_____ 192_

COUNTY_____ NAME OF EQUIPMENT_____ MOTOR NUMBER 4154 SERIAL NUMBER_____

DATE	GASOLINE GALS.	GASOLINE COST	OIL QTS.	OIL COST	GREASE LBS.	GREASE COST	REPAIRS OUTSIDE SHOPS	REPAIRS HIGHWAY SHOP	TIRES PARTS MATERIAL	LABOR CHARGES	TOTAL COST	MILES AND HOURS WORKING MILES	WORKING HOURS	LIGHT TRAVEL MILES	LIGHT TRAVEL HOURS	RATE WET	RATE DRY	STATE ROUTE NUMBER AND BETWEEN WHAT TOWNS	NATURE OF WORK PERFORMED	EQUIPMENT USED WITH (NAME AND SERIAL NO.)
JAN. 1924 1	115	20 90									20 90	79	60			3	2		TOTAL MILES	
FEB. " 2	255	56 10	42	7 46	9	72		20 00			84 28	193	118			7	7		79	
MCH. " 3	316	69 52	64	9 38	20	1 92					80 82	161	105	40	26	8	10		193	
APR. " 4	173	38 01	40	5 15	6	56					43 82	129	88			4	5		201	
MAY. " 5	319	66 04	38	4 84	20	3 10					73 94	283	162			8	14		120	
JNE. " 6	224	48 41	38	4 90	11	1 19			4 50	8 15	67 22	182	172	6	2	5	19		283	
JULY " 7	132	26 41	44	7 00	20	2 20		4 00			39 50	130	125			3	14		186	
AUG. " 8	210	40 80	56	9 80	22	2 42	2 50		3 25		58 77	151	161				21		130	
SEP. " 9	220	42 75	76	12 54	30	3 30			3 40		61 99	195	205			5	11		151	
OCT. " 10	290	51 64	74	12 21	41	3 51	1 15				68 57	229	143			4	12		195	
NOV. " 11	260	44 20	60	9 90	42	3 36					57 46	183	118	25	13	2	17		229	
DEC. " 12	240	40 80	48	8 21	24	1 92			1 60		52 53	220	123	1		3	13		208	
JAN. 1925 13	415	73 96	60	9 90	40	3 20			1 80		88 85	399	191			15	5		220	
FEB. " 14	417	90 36	78	12 87	48	7 44	1 00		1 95		113 51	360	163	22	10	12	9		399	
MCH. " 15	250	58 70	24	3 96	18	2 82	2 40	25			68 63	187	102	17	8	6	10		382	
APR. " 16	159	38 15	24	4 02	2	32					42 50	115	60	7	2	6	8		204	
MAY. " 17	270	62 10	40	6 00	12	1 92	2 25	1 08			73 35	218	86			10	7		122	
JNE. " 18	180	43 50	40	6 60	4	32	1 50	5 40			57 52	66	36	29	15	1	12		218	
JULY " 19	65	15 60	25	4 40				9 18			29 18	41	21			2	2		95	
20																			41	
11																				
ENTER ON THIS LINE ALL NO. NOT LISTED ABOVE TOTALS	3501	928 51	878	139 14	377	40 02	10 80	39 91	16 50	8 15	1182 43	3512	2229	146	75	104	148		3658	

IF EQUIPMENT IDLE STATE CAUSE ON EACH DAY ABOVE.
SHOW DATES OIL CHANGED_____

COST PER MILE 0.324

IN COLUMN "NATURE OF WORK PERFORMED" SHOW OPERATIONS AS "GRADING, GRADING AND DITCHING," "HAULING" OR "LIGHT TRAVEL."
IN COLUMN "STATE ROUTE NUMBER," SHOW DIRECTION FROM SECTION HEADQUARTERS AND ROUTE NO., VIZ: NO. 3 NORTH.

FIG. 2—PERFORMANCE RECORD OF TRACTOR COVERING 19 MONTHS OF USE

at $3.36, totaling $57.46, the cost of operation, with no repairs. The tractor was operated 208 miles at a cost of $0.276 per mile.

These monthly totals are posted to a form used as a ledger sheet shown in Fig. 2. Taking a period of 19 months, the entire time the tractor has been in service, there are shown these data: 302 days in operation with a consumption of 4,501 gal. of gasoline at a cost of $928.92, 878 qt. of oil at a cost of $139.14, 377 lb. of grease at $40.02, repairs $50.71, parts $16.50 and labor charges $8.15, totaling $1,183.44. The total miles operated being 3,658 gives a cost per mile of $0.324.

When this record is completed on each piece of equipment figures for all equipment of the same kind and class are consolidated according to time in service. The accompanying table shows as nearly as can be determined at this time cost figures on various sizes of equipment:

COST FIGURES ON 10-TON TRACTORS—CRAWLER TYPE

No.	In Service	Average Cost per Mile	
9	14 mos.	$0.645	Purchased
38	Government stock	.906	Overhauled by highway shop

5-TON TRACTORS—CRAWLER TYPE

No.	In Service	Average Cost per Mile	
53	6 to 18 mos.	$0.355	Purchased
24	Government stock	.606	Overhauled by highway shop

2-TON TRACTORS—CRAWLER TYPE

No.	In Service	Average Cost per Mile	
27	6 to 18 mos.	$0.271	Purchased
12	18 to 36 mos.	.448	Purchased

3-TON TRUCKS

No.	In Service	Average Cost per Mile	
89	Government stock	$0.185	Overhauled by highway shop

1-TON TRUCKS

No.	In Service	Average Cost per Mile	
60	6 mos.	$0.039	Purchased
34	18 mos.	.049	Purchased
18	18 to 36 mos.	.060	Purchased
38	Government stock	.058	Overhauled by highway shop

All machinery designated as government stock was furnished by the federal government from stock of surplus war materials and has been in use by this department approximately four years.

Openings in Intake Rack Decreased by Use of Reinforcing Bars

THE intake rack at the entrance to the tunnel supplying the Copco No. 2 hydro-electric plant in northern California consists of ¾x3-in. steel bars supported on horizontal rods 8 ft. apart. The spacing of 4½ in. between these bars was found to be too wide during the initial period of operation while there was a quantity of debris in the newly formed reservoir. A convenient and economical scheme was therefore adopted which decreased this spacing with the aid of some ¾-in. corrugated steel reinforcing bars left over from the concrete work.

The rack is 35 ft. deep but since the water level in the reservoir does not fluctuate more than a few feet and since only floating debris was giving trouble, it was considered sufficient to decrease the spacing in the height of rack between the horizontal bar at the top and the one 8 ft. below.

The ¾-in. reinforcing bars were first cut in 9-ft. lengths and about 6 in. at one end was bent over to form a hook. A supply of 4-in. lengths of the same bars was also cut up and one of these short lengths was spot-welded at right angles to the 9-ft. lengths near either end. The hooked end was then caught over the horizontal rod in the rack 8 ft. below the top, the short lengths welded to the main bar served as spacers to keep the bar in the middle of the opening and the upper end of the ¾-in. bar was then hammered down or "hooked" around the horizontal bar at the top of the rack.

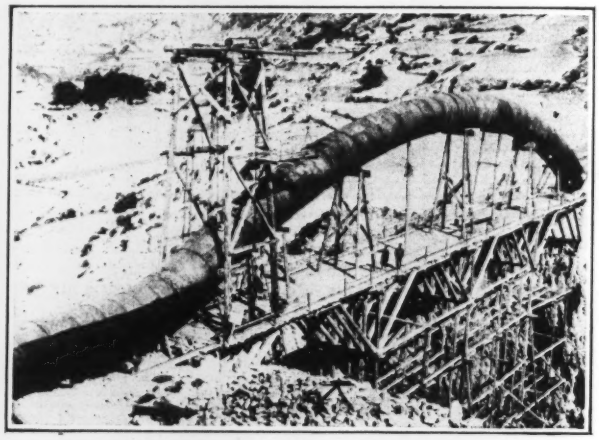
With ample capacity in the intake rack the decreased efficiency due to these additional bars in the top section is not a drawback and the scheme has the advantage that the bars can be removed on short notice at any time without loss of investment.

From Job and Office

Hints that Cut Cost and Time

Penstock Is Self-Supporting Arch in River Crossing

THERE has recently been constructed in the Department of Haute Alpes, France, as part of a hydro-electric project supplying power for the manufacture of aluminum products a river crossing wherein the



PENSTOCK ARCH UNDER CONSTRUCTION

penstock forms a self-supporting arch. The line crosses the Dirance River in a clear span of 223 ft. The pipe is 8 ft. 9¾ in. in diameter and the plate steel, composing the penstock in the arch, is 0.63 in. thick at the crown of the arch. That thickness prevails throughout most of the arch, though at the abutment it is increased to ¾ in.

The arch was constructed by a traveling gantry working along the top of a timber scaffolding built up to the abutment level of the arch. When it is known that the distance between high water level and the underside of the crown of the arch is 311½ ft. the difficulties in construction are evident. The arch has a rise of 13.8 ft. built to a radius of 229.6 ft.

The pipe line arch was constructed by the Etablissements Joya, of Grenoble, France.

From Job and Office

For Contractor and Engineer

Weights of Crest and Sluice Gates

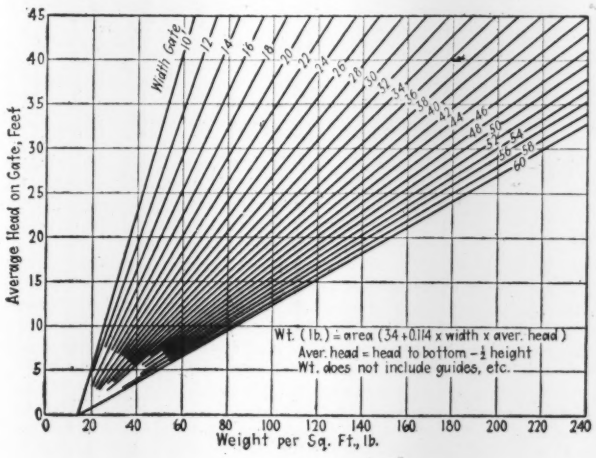
By Donald V. C. Birrell
With Charles T. Main, Engineer, Boston

A STUDY of the available published and office data on the weights of various types of large structural steel sluice and crest gates was made by the writer to arrive at a means of estimating weights and costs of similar gates for new developments. A formula based upon European practice came to his attention, but investigation showed it to be more liberal than American practice seemed to indicate.

WEIGHT OF GATES

Location	Type	Width (a)	Height (b)	Head to Bottom	Average Head (c)	Actual Weight, Lb.	Computed Weight,* Lb.	Difference, Lb.	Per Cent Error
Roanoke Rapids	Tainter	21.5	14	14	7	14,000	15,500	+1,500	+10.7
Bartlett's Ferry	Tainter	25	21	21	10.5	30,000	33,500	+3,500	+11.7
Baden	Tainter	25	11	11	5.5	15,000	13,700	—1,300	— 8.7
Heuvelton	Tainter	28	10.5	10.5	5.25	15,000	14,900	— 100	— 0.7
Oneida	Tainter	15	13.5	13.5	6.75	8,000	9,220	+1,220	+15.3
Rock. Ry. & Lt. Co.	Tainter	50	16	16	8	80,000	63,600	—16,460	—20.5
Tampa	Tainter	20	13	15	8.5	16,000	13,900	—2,100	—13.1
Bartlett's Ferry	Sliding head gate	16.5	20.5	60	49.75	38,000	43,100	+5,100	+13.4
Green Island	Sliding head gate	11.5	17	25	16.5	8,500	10,800	+2,300	+27.1
Flat Rock	Sliding head gate	11.5	13	16	9.5	7,400	6,950	— 450	— 6.0
St. Paul	Sliding head gate	14.5	22.25	31.75	20.62	17,500	21,950	+4,550	+26.0
Dominion Bridge	Sliding and roller	90	10	10	5	76,000	76,600	+ 600	+ 0.8
Dominion Bridge	Sliding and roller	40	21	21	10.5	60,000	68,800	+8,800	+14.7
Dominion Bridge	Sliding and roller	40	18	18	9	50,000	54,000	+4,000	+ 8.0
Dominion Bridge	Sliding and roller	50	15	15	7.5	58,000	56,700	—1,300	— 2.2
Dominion Bridge	Sliding and roller	50	43	43	21.5	427,000	347,000	—80,000	—18.7
Dominion Bridge	Sliding	14	13	21	14.5	13,000	10,400	—2,600	—20.0
Alabama Pr. Co.	Sliding	16.5	20	45	35	30,300	33,000	+2,700	+ 8.9
Alabama Pr. Co.	Sliding	30	14	19	12	39,100	31,500	—7,600	—19.4
Alabama Pr. Co.	Sliding	20	13	45	38.5	29,000	31,600	+2,600	+ 9.0
Alabama Pr. Co.	Sliding	20	16.5	45	36.75	37,700	38,800	+1,100	+ 2.8
Dominion Bridge	Stoney	32	11	19	13.5	28,000	29,300	+1,300	+ 4.6
Dominion Bridge	Stoney	40	18	26	17	66,000	80,300	+14,300	+21.7
Dominion Bridge	Stoney	16	21	29	18.5	23,000	22,750	— 250	— 1.1
Dominion Bridge	Stoney	16	24	32	20	30,000	27,100	—2,900	— 9.7
Panama Canal	Stoney	47.3	19	19	9.5	72,000	76,500	+4,500	+ 6.3

* Wt. (lbs.) = Area (34 + 0.114 width × Average Head) = ab (34 + 0.114 ac).


Average Head on Gate, Feet
Weight per Sq. Ft., lb.
Width Gate
Wt. (lb.) = area (34+0.114 x width x aver. head)
Aver. head = head to bottom – ½ height
Wt. does not include guides, etc.

WEIGHT OF GATES SHOWN GRAPHICALLY

This formula was made to fit the new data and in a slightly revised form is presented in the accompanying table which gives all the essential details on the various gates, the actual and the computed weights, and the per cent of error.

A chart based upon this formula is also shown, which gives the weight in pounds per square foot of gate area for gates of various widths under different average heads.

It will be noticed from this table that Tainter gates have been taken to follow the same rule, though in general it might be stated that the actual weight falls about 10 per cent below the computed.

While in most cases it was not possible to determine whether given weights included guides, rollers, and other equipment, it has been assumed that such are not included in the formula. Several of the wider variations from the general average may be accounted for by this fact.

Time and Intensity of Rainfall Equation

Correction is hereby recorded in the equation in the chart in the article, "Relation Between Time and Intensity of Rainfall" in the March 11 issue of *Engineering News-Record*, p. 419. The equation given was $i = 36/t + 20$ but should have been $i = 136/t + 20$.

Job and Office Notes

A New Type of Header for Expansion Joints in concrete paving has been developed by engineers of Division 7 of the California Highway Commission. It consists of three ¼-in. metal plates, cut to conform to the proposed cross-section of the pavement, and held together by six small clips. The outside plates are in halves and the center one in three parts, so that, when assembled, the header is rigid. The header is held in place while concrete is poured by stakes. When the concrete has set the center section of three parts is pulled out first by hooks applied to notches in the plate. This section is oiled before assembly and when it is out the side plates fall together.

Wooden horses barring the way of a pedestrian and making him walk around some place where men are at work digging up the street are likely to be considered by him as signs of hindrance or obstruction. But the Brooklyn Edison Co. evidently not only does not agree with this view but also wishes to make others look on the obstructions in a different light, for on the horses used to fence in their work, writes G. H. McKelway, of Westfield, N. J., they have painted in large letters:

THIS IS A SIGN OF PROGRESS
BROOKLYN EDISON COMPANY, INC.

By this means the company not only advertises itself by placing its name on the horses where it can be read by everyone passing by but calls attention to the fact that the work it is doing represents a distinct advance in the interests and facilities of the city.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

The Trouble With Contracting

Sir—Contractors universally speak of the "construction game." It is a game, in fact as well as name, under present methods. Moreover, it is a game that would interest the professional gambler only until he found that his chances of winning depended, not upon his skill, but upon the fact that the other fellow guessed wrong.

In the first place, in any construction work the weather element is a gamble; even the United States Courts have decided that the weather is not an act of God but a condition that a contractor must consider. Yet fully 75 per cent of the contractors today dismiss this important item with some such statement as, "If luck and the weather holds out, we will finish on time." They bid on that basis.

Next, there is the contractor possessing no actual cost data except possibly the knowledge that his total payroll, material bills, freight bills, and (the balance) incidentals total so much or approximately so much per mile, who adds maybe about half enough for any equipment or tools that he may need, adds a little for profit, and bids accordingly. Now along comes Jim Smith (he never seemed to get anywhere financially) and decides to give contracting a whirl. If Bill Jones can make money at it why can't he? He talks to fellows already in the game who have made money, writes for catalogs, which come in the next mail, followed on the next train, or over night by auto, by a salesman. The salesman has a grip full of cost data taken from the records of "some of the most successful contractors in the game today who use his equipment." He shows Jim costs that contractors have been trying for fifty years to achieve, and tells him what a fine thing he has been passing up. He promises to get him some special terms, yes even help him bid and through his (the salesman's) experience, gained through hearing bids read and talking with contractors, Jim gets a job—result, we have with us another contractor (?).

Then there is the contractor who gets prints on the job, does or does not look over the work, according to the way he feels, makes up a bid from costs he may have of some previous work, and figures out an apparently legtimate bid. This fellow goes to the place of opening of bids, finds several contractors of the types herein mentioned, feels that his figures do not give him a chance to get the work, takes a guess at how low the other fellows will bid, and cuts his figures accordingly.

Of course one has to have a certified check to bid. That does not amount to much; some bond or material salesman will get one for him. They want his business, and as he will be under obligations to them, they are sure of getting their money first.

These are only a few of the different types of contractors bidding and actually getting a very large percentage of public work today. The writer could describe a dozen other types just as amusing were they not so dangerous. Many public officials do not want to award work to these kinds of contractors, but public opinion and opposing political factions are elements that cannot be ignored and in order to keep down the cry of graft and collusion, it becomes necessary at least to give the low, irresponsible bidder the opportunity to attempt to complete the work.

The writer some time ago heard one of the foremost highway engineers in the country speaking in one of the large universities say, "that he was sick and tired of having contractors who had bid too low to complete the work according to specifications, come to him to have the specifications altered so as to allow them to complete the work without a loss." Yet at the next letting in that state, work was bid considerably lower.

The recent St. Louis case where salesmen, public officials, and clerks organized a construction company and placed the low bid on some public work, which bid was eventually thrown out, is one case where public officials dared public opinion and rejected the bid. The case was given the publicity necessary to convince the public that the low bid is not always the cheap bid.

The additional engineering expense, the actual loss to the public through inability to use the improvement, is many times the apparent saving between the low bidder and the bid placed by the lowest legitimate contractor who has the proper equipment, the experienced organization, and the proper financial standing necessary in order quickly and efficiently to prosecute the work according to specifications.

One solution seems to be a campaign of education—one that will place the facts where the thinking public can see them and see that the "lowest responsible bidder" is not always the cheapest bidder but many times is quite the reverse. This method would no doubt raise a cry of graft and favoritism and it will take mighty brave officials to face the storm that will immediately follow the awarding of contracts on this basis, but like all storms it would gradually die as confidence in the officials intrusted with the awards was restored by the results obtained.

Another and possibly more effective method is through the banker and bonding companies. These have effective organizations, and, being financial institutions in which men are spending a lifetime in the study of financial problems, must see that the present methods must in time pull down and possibly destroy some of our greatest institutions. They are also the smallest group in the makeup of the construction field, while without doubt the most important, and consequently can exert pressure that cannot be ignored. Some group or class must make a start and I confidently feel that the banker and bonding companies are the only ones in position to command respect at this time. Surely every one concerned would be better off. The banker eliminates his high-risk long-time paper; the material and machinery men sell just as much to a better class of trade; the public gets better work for actually less money; the contractor gets better prices and the possibility of a fair profit; the engineer is not required to superintend the work, as in many cases, and can devote his time to the actual engineering problems; and lastly the bonding companies are not forced to become contractors.

One has to be an optimist of the *n*th degree to vision the results mentioned above, yet they are possible and, through co-operation of the proper kind, highly probable. A remedy must be found or eventually the legitimate contractor will be forced from the field of public work to one where his efforts will obtain better returns.

A. C. FRICK,
General Superintendent, W. C. Meneely Co.

Decatur, Ill.,
Feb. 24, 1926.

The Importance of Careful Test Bearings

Sir—The article by R. L. Waring and C. T. Morris, in *Engineering News-Record*, Jan. 21, 1926, p. 109, describing some foundation problems encountered in the construction of a tall office building is very interesting.

While there is probably no doubt about the excellence of the finished work, it is the writer's impression after reading the account that the investigations of the site preliminary to design and construction left something to be desired. The location of the four bore holes, together with the data obtained from each test, would be desirable; an average boring record is in many cases of questionable value, particularly in the case of a considerable dip of the strata. It has been the writer's experience that even the information secured from closely spaced test holes of both wash and core borings is often misleading as to the exact nature of the underlying rock.

The importance of making careful borings and test pits at the site of any large structure cannot be too strongly emphasized. Incomplete data regarding the character of the soil and rock to be encountered will often create unusual problems of construction, and the successful handling of a difficult situation which has arisen through lack of adequate preliminary work is sometimes more heroic than praiseworthy.

WALTER W. HALL.

San Antonio, Texas,
Jan. 30, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Plans Bonds for Colorado River Development

Revised Swing-Johnson Bill Would Raise Money by a Large Bond Issue

Under the revised Colorado River development bill now before Congress (Swing-Johnson bill, revised in accordance with proposals of the Department of the Interior), the cost of the development of storage dams, canals and power house is to be covered by money raised through issue of bonds by the Secretary of the Treasury, to be amortized in 15 to 50 years from date of issue. Of the total issue of $125,000,000, the sum of $105,000,000 is designated for construction and the remainder for interest on bonds during the construction period.

A self-supporting, solvent undertaking is contemplated by the bill. It is to embrace a storage dam at Black Canyon or Boulder Canyon, for a capacity of 26,000,000 acre-ft.; a complete power plant and incidental structures; and a canal wholly within the United States from the Laguna Dam (or other diversion) to the Imperial and Coachella valleys in California. Construction is contingent on ratification of the Colorado River Compact (Santa Fe Compact) by at least six of the basin states and upon the conclusion of agreements by the Secretary of the Interior with the beneficiaries of the work adequate to cover all charges including amortization.

Power Contracts

With respect to power contracts, the Secretary is required to prescribe uniform regulations for the award of such contracts. Contracts are to be limited to 50 years but to have privilege of renewal unless the property be purchased. Conflicts between power applicants are to be decided with regard to the public interest and "in conformity with the policy expressed in Section 7 of the Federal Water Power Act as to conflicting applications," which gives preference to applications of states and municipalities. Joint use of transmission lines is provided for.

Use of the Storage Reservoir

Functionally, the storage reservoir is dedicated, first, to river regulation and flood control, second, to irrigation and domestic use, and, third, to power. All the works are to remain the property of the United States forever, and are forever to be managed and operated by the United States. Title to irrigation canals and appurtenent structures may after amortization be transferred to the districts or other units served. Power developed along the canal is to be credited to the irrigation beneficiaries.

With respect to irrigation, the Secretary is authorized to withdraw from entry all public lands found practicable of irrigation by the works contemplated in the act, and to open for entry all such lands in accordance with the reclamation law, the lands to be assessed their proportionate share of the construction cost of the canal and appurtenant structures. No provision is made for payment of interest on the construction cost of irrigation works.

The bill also includes a formal approval of the Colorado River compact, with waiver of the clause calling for approval of the seven states and provision that the approval shall become effective on approval by six of the states.

Engineering Fifty Years Ago

From *Engineering News*, March, 1876

Railways at the West

THE Western States, in one remarkable instance, are beginning to see that legislative interference frightens away capital. The legislatures of several of those States have laid a heavy hand upon the railways, and the consequence is that no more railways are constructed. We are aware that one reason for the entire cessation of enterprise in this department is the badness of the times; but there are parts of the West recently brought under cultivation where huge granaries are filled from the fields in their first stage of fruitfulness, and where the farmers are longing to see the ground broken for new railways to take their abundent stores of grain to market, and bring back in exchange the products of the East. That railways, if built, leading to these regions, would have plenty of freight, there can be no doubt, but the capitalist holds back for the reason that the Legislature assumes the right to say what shall be the measure of his profits. He may build a very convenient road, and it may be kept running with trains bearing freight, and yet be so regulated by the State Legislature that the capital investment shall yield no return. The railroad is as important to the Western farmer as the plough or reaping machine. If the Legislature of Iowa were to make a law that no ploughs or reaping machines should be sold in that state, except for half price, the makers of those implements would not be apt to send them to Iowa for a market.

Hearings on San Gabriel Storage Project

Federal Committee Hears Conflicting Claims of Los Angeles County and Pasadena

Formal hearings are nearing completion in Los Angeles before a federal committee, appointed to report on conflicting applications made by the Los Angeles County Flood Control District and the city of Pasadena for rights-of-way in connection with proposed storage dams on the San Gabriel River. The committee consists of F. J. Safley, chairman, U. S. Land Office, Salt Lake City; F. E. Bonner, district engineer, U. S. Forest Service, San Francisco; and H. D. McGlashan; district engineer, U. S. Geological Survey, San Francisco.

Two Dams Proposed

The Los Angeles County Flood Control District proposes the construction of a dam at the Forks site on the San Gabriel River, to impound 240,000 acre-ft. Pasadena has for some years had under consideration the plan of developing a 65,000 acre-ft. storage project at a point 6½ miles downstream from the Forks, at a site known as Pine Canyon reservoir No. 2. There is no conflict between the two projects except as to the location of a construction road or railroad to the Forks site. Pasadena seeks to have this road or railroad built above its flow line so that water could be stored prior to the completion of a dam at the Forks site. This led to the controversy and the appointment of the committee by the Departments of the Interior and Agriculture to hold hearings and report to Secretaries as to the conflicting claims.

Pasadena Water Supply

The Pasadena Water Department estimates that the water plane from which the city draws a large part of its supply will fall 144 ft. in the next six years and states that immediate steps to supplement the present supply by a San Gabriel source are urgently needed. The average annual run off replenishing the underground basins from which Pasadena draws its supply is 7,000 acre-ft. less than the annual draft on those basins. Even if the city found it feasible to join with the Flood Control District in the use of the proposed Forks reservoir, it would not be feasible to postpone additions to the present supply so long as would be necessary for the development of storage at that site. Particularly is it not desired to do so when the independent storage project at the Pine Canyon site would provide the needed additional supply in three to four years. Moreover, Pasadena points out that the proposed dam at the Forks site would require 4,000,000 cu.yd. of concrete, or 16.4 cu.yd. per acre-ft. of storage as

(*Concluded on p.* 503)

Over a Billion Dollars for Rural Roads in 1926

Highway construction and maintenance in 1926 will equal and possibly exceed that of any previous year, according to estimates from the various states compiled by the Bureau of Public Roads. A total of $1,030,286,948 is available for the construction and maintenance of all rural roads. About 58 per cent or $598 590,948 is to be available to the state highway departments, of which $461,515,400 is for construction and $137,075,548 for maintenance. These funds will provide for the construction of 6,751 miles of asphalt, concrete and brick paving, 14,320 miles of sand-clay, gravel and macadam and 8,145 miles of improved earth road. The states also plan to maintain 234,582 miles of road The total expenditure by counties and local units for both maintenance and construction is estimated at $431,696,000, which is less than the similar estimate made one year ago by about $31,000,000. This reduction is more than offset however by the increase of more than $58,000,000 in funds estimated as available to the state highway departments. The funds available as reported by the various states and the portion of the state funds derived from Federal aid are as follows:

	Probable Expenditure by State Highway Departments	Federal-aid Funds Available to States*	Probable Expenditure by Local Authorities
Alabama	$9,900,000	$3,547,911.69	$12,000,000
Arizona	4,200,000	3,084,742.68	630,000
Arkansas	6,500,000	1,534,751.77	9,000,000
California	14,000,000	4,248,299.76	23,000,000
Colorado	4,550,000	3,285,370.65	5,000,000
Connecticut	7,785,289	1,611,062.57	2,500,000
Delaware	2,930,000	367,537.65	900,000
Florida	14,000,152	1,400,910.74	18,000,000
Georgia	7,324,750	1,931,087.02	13,000,000
Idaho	2,837,000	1,271,409.28	1,500,000
Illinois	46,200,000	6,674,248.74	20,000,000
Indiana	13,200,000	2,382,667.87	40,000,000
Iowa	13,584,108	4,028,631.46	16,000,000
Kansas	9,072,000	3,073,831.15	10,000,000
Kentucky	12,000,000	2,486,349.23	10,000,000
Louisiana	9,250,000	1,856,350.57	7,000,000
Maine	8,983,400	1,513,478.38	3,900,000
Maryland	7,116,398	654,830.74	3,200,000
Massachusetts	13,000,000	2,673,200.94	12,000,000
Michigan	11,500,000	4,603,378.63	22,000,000
Minnesota	21,500,000	2,111,863.44	6,500,000
Mississippi	6,250,000	1,698,458.08	6,000,000
Missouri	28,076,000	2,600,235.10	12,000,000
Montana	1,350,000	5,714,746.27	1,000,000
Nebraska	6,500,000	3,941,841.00	8,500,000
Nevada	1,670,000	1,049,593.49	400,000
New Hampshire	3,550,000	511,347.83	1,500,000
New Jersey	22,900,000	985,680.83	8,300,000
New Mexico	3,555,553	2,750,373.17	200,000
New York	35,750,000	6,938,224.36	26,641,000
North Carolina	16,000,000	1,715,137.99	10,000,000
North Dakota	5,450,000	2,506,152.20	3,500,000
Ohio	25,500,000	4,502,826.16	20,000,000
Oklahoma	10,000,000	1,894,068.61	12,000,000
Oregon	7,000,000	1,319,943.74	7,000,000
Pennsylvania	63,550,000	3,699,149.10	12,500,000
Rhode Island	3,790,000	675,753.65	875,000
South Carolina	5,540,000	892,885.46	2,500,000
South Dakota	3,350,000	1,282,672.87	5,250,000
Tennessee	18,000,000	2,374,596.79	9,000,000
Texas	28,000,000	4,979,640.84	16,000,000
Utah	3,640,798	1,502,010.18	500,000
Vermont	3,530,000	801,796.98	700,000
Virginia	10,285,500	1,481,535.84	2,600,000
Washington	9,000,000	1,527,002.22	11,000,000
West Virginia	13,750,000	912,454.24	6,000,000
Wisconsin	20,970,000	5,143,634.95	10,700,000
Wyoming	2,200,000	1,024,811.51	900,000
Totals	$598,590,948	$118,768,488.42	$431,696,000

* Included in total probable expenditure by State highway departments.

New Jersey Engineers Meet at Newark

Society Endorses Bill to Classify Licensed Engineers Into Six Groups

Out of 1887 engineers and land surveyors licensed to practice in the State of New Jersey 988 are members of the New Jersey Society of Professional Engineers and Land Surveyors. Announcement of this membership was made at the Third Annual Meeting of the society in Newark, March 17. Gratification was expressed generally by the members at the excellent growth of the society in the two years of its existance.

To Classify Engineers

The society endorced the bill now before the New Jersey legislature giving authority to the State Examining Board to classify applicants for licenses in the various branches of professional engineering. The titles specified in the bill are civil engineer, mining engineer, mechanical engineer, electrical engineer, chemical engineer, land surveyor "and such other branches of professional engineering as the Board may consider subject to this act." The certificates issued to the registrants will entitle the holder to use the title of the branch or branches of the profession for which he has qualified.

The society also endorsed bills providing (1) that all departments and boards of the state government shall employ as engineers in responsible charge only such as have been licensed by the state prior to their designation, appointment or employment by said department or board; and (2) that the work done by an architect, engineer or land surveyor shall constitute a lien on the property affected by the work.

The banquet in the evening was marked by the presentation of tokens of esteem to the retiring president, Roscoe P. McClave, county engineer of Bergen County, and to Hugh A. Kelly, secretary. Mr. Kelly arrived at his "engineering majority" on the day of the meeting, having completed 21 years of service in engineering.

The following officers were elected: President, Thomas J. Wasser, Jersey City; first vice-president, Peter Daly, North Bergen; second vice-president, F. C. Carstarphen, Trenton; directors for three years, John P. Fallon, Elizabeth; Col. W. F. Whittemore, Newton; C. Campbell Hunicke, Palisade; Alex. H. Nelson, Atlantic City. To serve out term of T. J. Wasser on board of directors, James Costello, Newark was elected.

Civil Service Examinations for Barge Canal Superintendents

The last link between the New York State Barge Canal and political patronage has been broken by Col. Frederick S. Greene, state superintendent of public works. This final move has been made by shifting the eight section superintendents from the exempt list to civil service.

Considerable opposition is being expressed by political leaders as it is claimed practically all of the present superintendents will be eliminated by age or other qualification. In commenting on this move Col. Greene expressed the idea that he wanted "competent men with engineering experience for this work, young enough to put on a pair of hip boots and get in when there is a crisis. It is a part of the general plan of reorganization in this department. We are past the other thing."

East St. Louis Drainage Canal Contracts Invalid

A decision of the Illinois Supreme Court sustains that of the Circuit Court in holding that contracts for sections 1 and 2 of the drainage canal at the foot of the bluffs, at East St. Louis, Ill., are illegal and in granting a permanent injunction restraining the East St. Louis Levee and Sanitary District from proceeding with the construction. The Levee Board is found to have exceeded its authority by letting the contracts and thus incurring indebtedness in excess of 5 per cent of the valuation of taxable property in the district. It is stated that the present board has been advised that the excess expenditure is recoverable from the members of the former board, which let the contracts. These contracts were let in 1920 for about $1,504,795. Suit was entered in 1924 and the circuit court decision was given in June, 1925. The company which had taken over the work from the original contractors appealed to the Supreme Court, whose decision has now been given.

Standard Specifications for All City of Detroit Purchases

The standardization of specifications for all supplies for the City of Detroit is being considered by the mayor, controller, and Dan E. Trombly, acting purchasing agent.

Lake States Win Point in the Chicago Diversion Suit

A motion by the defendants to dismiss the suit of the states of Wisconsin, Ohio, Minnesota and Pennsylvania against Illinois and the Chicago Sanitary District was denied by the United States Supreme Court, March 22, pending arguments on the suit itself at a date which has not been fixed. The suit involves the authority of the Secretary of War to permit the Sanitary District to divert any water whatsoever from Lake Michigan, together with other questions raised in the lake levels controversy. The motion to dismiss this suit was based on the ground that the Supreme Court, in the case decided last year, had determined the main questions now raised.

Rule on Collection of Income Tax from Municipal Employees

In accordance with Sec. 1211 of the Revenue Act of 1926, the Commissioner of Internal Revenue has notified the various district collectors to abate, credit or refund, as circumstances demand, income taxes charged up to and including 1924 on sums charged or paid on income for personal services as officers or employees of state or municipal governments, subject to the statutory period of limitations. Similar income for 1925 and subsequent years is to be collected on compensation for services "in connection with the exercise of a nongovernmental function of the state or political subdivision." Nongovernmental functions have previously been held by the commissioner to include water-works, commercial lighting, electric railways and other utilities, but the Federal District Court of Michigan has held that the operation of street railways is a governmental function and the decision has been appealed to the United States Supreme Court.

Dakota Engineers Hold Meeting

Greater activity of the North Dakota Society of Engineers, with steps to include mechanical and electrical as well as civil engineers, is planned as a result of the annual meeting held jointly with the Fargo Engineers Club at Fargo, N. D., on March 5 and 6. The principal papers were Fargo's New Gas Generator; Glover-West Retort System, by Lawrence Hislop, engineer of the West Gas Improvement Co.; Water Treatment in Relation to Railway Problems, E. M. Grime, engineer of water service, Northern Pacific Ry.; Problems of the Telephone Engineer, G. C. Johnson, district engineer, Northwestern Bell Telephone Co.; Economic and Political Problems of the Great Lakes and St. Lawrence Waterway, Dr. A. H. Benton, North Dakota Agricultural Experiment Station. Officers elected are as follows: President, Robert T. Jacobsen, city engineer, Fargo; first vice-president, John Shaw, vice-president of the Haggart Construction Co., Fargo; second vice-president, David R. Jenkins, professor of electrical engineering, University of North Dakota; secretary and treasurer, Paul M. Barnes, city engineer, Valley City, North Dakota.

Ice Jams Do Much Damage Along Allegheny River

One Bridge Wrecked by Overturning of Pier—Another Bridge Seriously Damaged

Special Correspondence

Ice jams in theh Allegheny River which have been causing serious trouble for a number of weeks, broke up on March 23 and went down the river without adding to the damage already done.

Movement of the ice gorge wrecked three spans of the Big Rock Bridge below Franklin, Pa., on March 21. The structure was a two-story four-span truss bridge. The lower floor, abandoned some six years ago, originally carried the highway and the upper one the Oil City-Franklin traction line. In addition to the truss spans over the river, the traction company had a plate girder span over the Pennsylvania Railroad tracks, one end of which rested on the bridge abutment, the other being connected to a short steel approach trestle.

The ice pressure wrecked one pier of the bridge, causing two truss spans at the east end to fall into the river. The one pulling on the west end of the bridge caused that portion to follow, leaving the plate girder span hanging at an angle of 45 deg. across the railroad tracks.

An electric car carrying five passengers had passed over the bridge eight minutes before. Some time ago it was announced that bus service would replace this electric line so that the bridge will not be rebuilt.

In Franklin the principal damage has been in a comparatively small low lying residential section. The business section is well above flood danger, and only one industry has been materially affected.

Much Damage at Oil City

Down the river at Oil City the damage has been greater. Following the flood three weeks ago, when the central station of the Citizens Light and Power Co. supplying electricity to Oil City, Franklin and Titusville was suddenly put out of commission for nearly a week by a movement of the ice gorge, the company made a temporary connection with the transmission line of the Penn. Public Service Co. which connects the Clarion River Hydro-Electric Plant with the Erie System. This connection was put into use on Sunday, March 21, when the power house was again flooded, there being more than 5 ft. of water on the turbine room floor. Street car service was halted when the rotary converter supplying direct current to the trolley lines was submerged. Service was again interrupted Monday afternoon, for about six hours, when ice carried out a transmission tower near the power house.

Reno Bridge Endangered

One deck truss span of the Reno Bridge, another combined highway and street car bridge, has been moved about one foot by the pressure of the ice and was in grave danger for a time. As this bridge carries the 11,000-volt transmission line connecting the local power station with the system of the Penn. Public Service Co. its destruction would have meant another serious interruption in electric service.

Although the municipal water works pump station was put out of commission for fifty hours by the flood three weeks ago, emergency measures taken to prevent a repetition of thi soccurrence were successful.

The most important business streets of Oil City were covered Monday with from a few inches to 3 ft. of water. Practically all of the principal industries of the city have been damaged to some extent.

William H. Finley Dies

William H. Finley, consulting engineer, Chicago, formerly chief engineer and later president of the Chicago & Northwestern Ry., died at his home in Wheaton, Ill., of pneumonia, on March 17. Mr. Finley was a native of Delaware, born on a farm in Newcastle County, Jan. 22, 1862. His first technical experience was as a draftsman with the Edge Moor Iron Co., at Wilmington, Del. In 1887 he entered the bridge and building department of the Chicago, Milwaukee & St. Paul Ry., leaving in 1892 to go to the Chicago & Northwestern Ry. as engineer of bridges. Later he was principal assistant engineer, assistant chief engineer and chief engineer, being appointed to this last position in 1914. In 1918, he was elected president of the railway company, including its subsidiary, the Chicago, St. Paul, Minneapolis & Omaha Ry., succeeding R. H. Aishton. This position he resigned in June, 1925, on account of ill health and a little later he opened an office in Chicago as consulting engineer. During the past winter he spent some time in Europe studying the use of railway motor cars and oil-engine locomotives. Mr. Finley was a member of the American Society of Civil Engineers and the American Railway Engineering Association and was past president of the American Association of Engineers and the Western Society of Engineers.

Hearings on San Gabriel Storage Project

(*Concluded from p. 501*)

compared to 7.2 cu.yd. per acre-ft. of storage at Pine Canyon.

Pasadena suggests that a possible joint storage site much more favorable than the Forks is available 7 miles downstream from the Forks site, at a location known as the Granite Dike site. While this site has not been core-drilled, surface indications are more favorable than at the Forks site, Pasadena states, and assuming the same depth of excavation, there would be a saving of 1,500,000 cu.yd. of concrete for the same 240,000 acre-ft. storage. This would mean the possible saving of about $8,000,000.

N. Y. Section A.S.C.E. Considers Structural Safety Bill

Proposed legislation for structural safety was the subject of the meeting of the New York Section of the Am. Soc. C. E. March 17. The meeting was held in co-operation with the New York and Brooklyn chapters of the American Institute of Architects and the New York Society of Architects. Representatives of these societies as well as others interested in means of promoting structural safety and the relation of the architectural and engineering professions to it spoke on the subject which had been incorporated into a bill ready to be introduced in the legislature as soon as possible. The bill was drafted and adopted in principle by the Joint Committee on Structural Safety composed of representatives of seven architectural and engineering societies of the New York metropolitan district.

Each speaker was positive in the assertion that the passage of such a bill was urgent and with the exception of a few small changes in technical structure that the prepared bill was entirely adequate. William P. Bannister, secretary, Architects Registration Board of the State of New York, and Robert D. Kohn, architect, New York City, both expressed the opinion that the passage of the bill depended upon how completely the general public became aware of the haphazard manner in which much construction is being carried on today. The other speakers, too, held the opinion that general knowledge of incompetent building would result in a public demand for such a structural safety bill.

The bill provides in its main intent that permits to commence building shall be issued by the proper city or state department against detail drawings and specifications signed by the architect or engineer and that upon completion of the work a certificate be filed by the architect or engineer stating that he has supervised the entire work of construction and that those portions upon which its structural safety depends have been executed in accordance with these specifications and detail drawings. The bill applies to all buildings of more than three stories in height or more than 35 ft. in height. Both the architect and the structural engineer must be registered and licensed in accordance with the general business laws of the State of New York.

Other speakers on the program who presented short papers upon the bill were. William Cullen Morris, civil engineer; Col. W. G. Eliot, chairman, Engineers Licensing Board of the State of New York; Charles L. Eidlitz, chairman, Structural Steel Board of Trade.

Waco Voted Not to Abandon Manager Plan of Government

The voters of Waco, Texas, recently voted not to change back from the city manager to the aldermanic type of government, we are informed by John G. Stutz, executive secretary, International City Manager's Association, Lawrence, Kan., instead of voting to adopt the manager plan, as stated in our issue of Feb. 11, p. 256.

Open First Station on Difficult Subway Extension

The first section of the Queensboro Subway extension from Grand Central Station to Eighth Ave., New York City, was opened on Mar. 22. This makes it possible for the trains coming from Long Island City to run to a station between Fifth and Sixth Aves.

The work which involves 4,000 ft. of the most difficult forms of subway construction in solid rock, is being carried out at a cost of nearly $4,000,000. Some of the problems involved were: passing 5½ ft. below an old 6 ft. sewer, blasting within a few inches of the floor of the Interborough subway in coming up under it and blasting within 30 ft. of the main water supply tunnel. The remainder of the extension will be completed in the early summer.

Contractors' Assoc. of Northern California to Join A.G.C.

The returns from a letter ballot sent to members of the Contractors' Association of Northern California and canvassed on Mar. 17 showed a vote of 10 to 1 in favor of affiliation with the Associated General Contractors of America.

No delay is anticipated in the matter of application for a charter for the San Francisco Chapter and completing its organization.

The Association will bring to the A.G.C. 75 regular members and 36 associate members engaged in engineering contracting in Northern California particularly in the construction of highways, railways, tunnels, dams, etc.

The Association has for some time maintained its own indemnity exchange and recently inaugurated in conjunction with state officials a clearing bureau of contract investigation in the interest of improved conditions in the construction of public works.

Port Authority Reorganized for Bridge Construction

Julian A. Gregory has resigned as chairman of the Port of New York Authority in order to devote more time to his law practice. Former Governor George S. Silzer has been appointed by Governor Moore or New Jersey to replace Mr. Gregory on the commission.

Subsequent to this, there has been a general reorganization of the Port Authority in order to cope with the increased work involved in the building of two bridges from New Jersey to Staten Island and the preliminary work on the proposed Hudson River Bridge.

John E. Ramsey, heretofore head of its bureau of accounts and statistics, has been made chief executive officer and will have direct charge of all the work of the Port Authority under the commissioners. Billings Wilson, head of traffic bureau, has been made deputy manager. W. W. Drinker, who was chief engineer, has been relieved of the detail attached to that office and has been made chief consulting engineer.

The work on the bridges will be under general charge of O. H. Ammann as bridge engineer, with W. J. Boucher as construction engineer.

Promotion Methods in Golden Gate Bridge Project Disapproved

At a meeting of the joint council of engineering societies of San Francisco on March 9 there was a general discussion of the Golden Gate bridge project and the present situation with regard to the proposed bridge district in which funds for construction would be raised. Attention was directed to the fact that Lake, Mendocino, and Humboldt counties have withdrawn their approval of the district and other counties desire to do likewise.

Reasons for this withdrawal were that, as the matter now stands, in addition to the provision for bond issues and in case the revenue from the bridge should be inadequate an annual tax could be levied on all property within the counties in the district to provide funds which the district's board of directors could expend to meet any deficit in construction costs, maintenance costs, operating losses, or payments of principal and interest on the bond and that this taxation and expenditure could go on year by year indefinitely unless stopped by action of the state legislature.

Formal action of the council in the matter was as follows: "The joint council of engineering societies of San Francisco, having considered all data available on the proposed Golden Gate bridge, concludes:

"1. That the project for bridging the Golden Gate has not as yet been adequately investigated, and

"2. That council does not approve of the methods by which plans for the bridge district have thus far been advanced.

"Council believes that any project for bridging the Golden Gate should first have a proper investigation by a commission of not less than three competent bridge engineers. This investigation and necessary studies, including borings, would probably cost not less than $500,000.

"Having made such studies, it would then be possible (a) to determine the type of bridge that would be feasible, and (b) to prepare plans and estimates of cost. Only after obtaining such data would it be possible to make an economic study of whether the cost of such a project would be justified. These data and this economic study, in the opinion of council, are unquestionably necessary preliminaries to the formation of a bridge district on a sound and economic basis."

Chicago Adopts Building Tile

After arguments extended over many months and under pressure from Mayor Dever, the city council has passed an ordinance which permits the use of hollow hard tile for buildings. In spite of strong support based on the economy and efficiency of tile, the council committee has long refused to change the measure excluding tile, and it finally submitted an ordinance which, according to report, would in effect have continued the present exclusion. Fortunately, however, the defective features of this ordinance were discovered and it was defeated.

Engineering Societies

Calendar

Annual Meetings

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, St. Petersburg, Fla., March 29-31, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Spring Meeting, Kansas City, Mo., April 14-16; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 10-13, 1926.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Buffalo, N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11, 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 13-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

INTERNATIONAL CITY MANAGER'S ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The Michigan Engineering Society has vacated its former offices in Detroit and has turned its secretarial work over to the Detroit Engineering Society to be handled by E. L. Brandt at the offices of the latter society at 478 West Alexandria Avenue, Detroit. The managing secretaryship of the Detroit Engineering Society, the secretaryship of the Associated Technical Societies of Detroit and the business management of the *Michigan Engineer* will continue to be handled by Mr. Brandt.

Personal Notes

COLONEL GILBERT A. YOUNGBERG, United States district engineer since 1922 for the peninsula of Florida, was relieved March 20 and will probably take up the practice of consulting engineering in Florida. During his service in Florida there has been extensive work in the St. Johns River and in the harbors of Tampa and Miami. He has a long record of valuable service elsewhere, and in the World War he won the distinguished service medal. Lieutenant Colonel Mark Brooke will succeed him in Florida; he has been on general staff duty in Washington, D. C. He saw service in camp construction in France, and previously in Cuba in 1907 and 1908. In Washington he has been assistant to the engineer commissioner of the District of Columbia and in charge of all above-the-surface engineering.

MORGAN F. LARSON, county engineer of Middlesex County, New Jersey, has been elected president of the New Jersey Senate.

SPOON, LEWIS & CAMP, civil engineers with office in Greensboro, N. C., announce the opening of an office also in the Flatiron Building, Asheville, N. C. C. H. Moneypenny is chief engineer of the firm.

R. M. SMITH has been appointed chief engineer of the Ontario Department of Highways, he has been a provincial engineer in this department. The newly appointed assistant chief engineer is A. A. SMITH, who has been a division engineer.

HARVEY O. SHERMERHORN, until recently New York state division engineer at the Hornell, N. Y., office, has been transferred to Albany and placed in charge of the new grade crossing elimination work with the title of chief engineer of grade crossings and bridges, in the state department.

BEN C. GERWICK has resigned from the Healy Tibbitts Construction Co. to open an office at 112 Market St., San Francisco, under the firm name of Ben C. Gerwick, Inc., contractors and engineers. Attention will be given particularly to wharves, terminals, bridges, foundations, and waterfront and subaqueous work generally. Will F. Morrish is secretary-treasurer of the new firm.

ARTHUR B. DAVIS, New Orleans, La., contracting engineer for the Virginia Bridge & Iron Works, has been transferred to Memphis, Tenn., to take charge of the office for the company there. Mr. Davis has been secretary of the Louisiana Section of the American Society of Civil Engineers. His successor at the New Orleans office of the company will be, temporarily, ASHTON R. PEYTON, at present manager of the Birmingham office.

A. C. LOVE has been appointed state highway engineer of Texas; he was formerly county engineer of Jefferson County, Texas, and more recently county engineer of Liberty County, also formerly was a professor of civil engineering at Texas A. & M. College. The new engineer for Liberty County is S. J. TREADWAY. W. C. YEAGER, assistant city engineer of Houston, Texas, has been appointed division engineer of Division 12 for the state highway department, succeeding W. S. MANTEL, resigned; and A. MCCORMACK, engineer of Madison County, has been appointed state division engineer succeeding MARK SWAIN.

EDGAR DOW GILMAN, assistant professor of civil engineering in the University of Cincinnati, has been appointed director of the new department of public utilities in Cincinnati. Mr. Gilman's varied experience, since graduation from the University of Wisconsin, has included machinery installation at the Panama locks, design and supervision of construction of steel and concrete structures for the Duluth, Minn., department of public works, and design of buildings, dams and lock gates, also service with the 473rd Engineers.

R. S. TAGGART has been appointed district engineer for the Portland Cement Association in charge of its Pittsburgh office; Mr. Taggart has been connected with the Portland Cement Association since 1921 and served as field engineer in Ohio and western Pennsylvania.

Obituary

CLARK I. WILCOX, Pittsburgh, Pa., treasurer of the Pitt Construction Co., died March 12 at his home in Pittsburgh, aged 48 years. Mr. Wilcox had devoted his time to viaduct construction.

WILLIAM E. TENCH, Detroit, Mich., railroad construction contractor and engineer, who was engaged in the building of the Niagara Falls Gorge Route twenty years ago and since then consultant on many engineering works for the Michigan Central, Pere Marquette, Grand Trunk and other railroads, died March 9 from injuries received when he was struck by an automobile in Detroit; his age was 68 years.

JOHN D. FORTER, president of Porter Brothers Co., Spokane, Wash., died February 24 after an operation in a hospital in Spokane; his age was 66 years. Since 1886 Porter Brothers has done railroad construction, parts of the Montana Central line, of the Great Northern, and of lines in the East. During the War the firm was employed on the army base terminal at Norfolk, Va., and Camp Custer in Michigan.

JAMES MULCAHY, construction engineer, formerly of Atlanta, Ga., but for some years engaged in engineering and construction work in the Canal Zone and in Central and South America, died early in March from injuries received in an accident on road work in Nicaragua. For the past three years he had represented the C. A. Bayley Construction Co., of New Orleans, in construction work in the Canal Zone and railroad work in South America. He was born in North Hadley, Mass.

HARRY S. DOUGLAS, U. S. assistant engineer, serving in the fourth district office of the Mississippi River Commission at New Orleans, died Feb. 20 in New Orleans in his 70th year. Mr. Douglas was born in Canada and educated at the Institute of Belfast, Ireland, and had served in the United States Engineer Department on the New Orleans station since 1873, and in the Fourth District of the Mississippi River Commission since 1882. He was engaged on surveys and projects on the waterways of Texas and Louisiana and in the designing and construction of floating plant, jetties, mattresses, etc.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Progress on Wire and Sheet Metal Simplification

At the conference on simplification of wire and sheet metal gages held in the Engineering Societies' Building, New York City, March 18, 25 organizations interested in all phases of the subject were represented and definite progress was made.

Unanimous decision was reached that the numerous conflicting gage systems are causing intolerable conditions and that industrial practice should be unified in a simple consistent plan. The detailed technical work in connection with this plan will be in the hands of a sectional committee broadly representing all interested industrial groups and working under the auspices of the American Engineering Standards Committee.

The trend of opinion at the conference strongly favored the elimination of all gage numbers and the use of a simple system of designating sizes in decimals of an inch. The decision, however, on the exact form of the solution was left to the sectional committee.

How to Attach Wire Rope Sockets

The following method is suggested by A. Leschen & Sons Rope Co., St. Louis, Mo. At a distance from the end of rope equal to the length of the basket of the socket, serve rope securely with wire. Open rope and cut out hemp core. Clean the wires well with kerosene or turpentine and wipe thoroughly dry. Separate the wires and soak five minutes in a solution one-half muriatic acid, one-half water. Clean them off and dip in a solution one-third muriatic acid, two-thirds water. Then bring wires together and bind with a small wire at extreme end.

Clean inside of barrel of socket with kerosene or turpentine and wipe dry. Next, coat inside of the socket barrel with solution one-half muriatic acid, one-half water; allow this to dry of itself, after which heat the socket until it becomes warm, but not hot; then apply to inside of the barrel a second solution consisting of one-third muriatic acid, two-thirds water.

Force socket over wires until they are even with top of basket of socket. Then remove small wire binding at end of rope, allowing wires to spread in bowl of socket. Place some fire clay or wrap paper around rope at base of socket to prevent spelter from running out. Hold socket and rope vertical, and pour melted zinc into basket of socket until top of all wires is covered. Allow zinc to cool while socket is in vertical position.

When holding the socket and rope vertically, see that the rope is not bent to too short a radius. The effect of too short a radius is to force the wires out of their true relation and develop unequal stresses when the cable is in service.

Resocketing—As the vibration in the rope comes to a sudden stop at the socket, the wires at this point ultimately become crystallized. Moisture is also apt to concentrate around the socket, with the result that intensive corrosion develops.

To maintain safety a section of the rope next to the socket should be cut off and the socket reattached to the cable, thereby eliminating the affected section of rope. This resocketing or recapping should be done at least once every six months, and under many conditions every three months.

International Roads Exhibition in Buenos Aires

An international exhibition of roads, transport and touring will be held in Buenos Aires, Argentina, opening May 25, 1926, and continuing for several months.

The part of the exhibition dealing with roads will be divided into nine sections treating all the phases of construction, maintenance and equipment. A special section will provide for a competition, open to large road making and paving companies, in paving roads on the exhibition grounds with different materials. The transport division of the exhibition will be divided into seven sections showing historical exhibits of primitive and modern vehicles in Argentina and the use of vehicles for passengers and merchandise. The touring group in four sections will consist of routes and resorts, maps and guides, travel agencies, tourist organizations, etc.

Applications for stands and space may be made by cable. Copies of the program in English may be obtained by applying to the Transportation Division of the United States Department of Commerce or through the district offices of the Bureau of Foreign and Domestic Commerce.

Business Notes

MONARCH TRACTORS, INC., Watertown, Wis., announces the completion of its plans for removing the business to Springfield, Ill. Under these plans a new Illinois corporation has been organized, to be known as Monarch Tractors Corp. The officers of the new company are: R. W. Gotshall, president; H. B. Baker, vice-president; R. C. Lanphier, vice-president, Owsley Brown, secretary and treasurer. Mr. Gotshall and Mr. Baker came to the company several months ago after many years' service in the Holt Mfg. Co. at Peoria. Other members of the Monarch Tractors Corp. who were associated with Mr. Gotshall and Mr. Baker in the Holt company are E. F. Norelius, chief engineer, J. A. Geiser, general factory superintendent, W. J. Gottschalk, assistant treasurer, and W. V. Kauffman, purchasing agent.

NEPTUNE METER CO., New York City, announces that the manufacture of the Lambert water meter and all of its repair parts will be continued by the newly formed Thomson Meter Corp., operating as a subsidiary of the Neptune company. Plans involve the installation of new factory equipment and an increase in production of the Lambert meters of both the current and compound types.

UNITED ALLOY STEEL CORP., Canton, Ohio, announces that L. S. Hamaker is now in full charge as advertising manager. Mr. Hamaker has been with the company for six years in sales and advertising work.

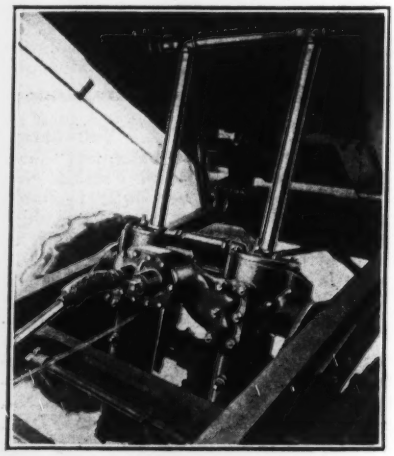
J. W. MILLSPAUGH, assistant works manager, Chain Belt Co., Milwaukee, Wis., has been advanced to the position of works manager recently to succeed J. C. Merwin who has been elected second vice-president. Fred Kau, a member of the Chain Belt organization for more than 16 years, is now assistant to Mr. Millspaugh.

Equipment and Materials

New Features on Oil-Operated Under-Body Hoists

Changes in the design of the oil-operated under-body hoist manufactured by the Heil Co., Milwaukee, Wis., make possible a higher dumping angle, reduced weight, and eliminate many oil troubles.

The oil reservoir is now cast integral with the hoist cylinder, replacing the old sheet-metal tank and connections. This construction is said to prevent the possibility of oil leaks and permits the servicing of any part of the hoist without the necessity of removing any

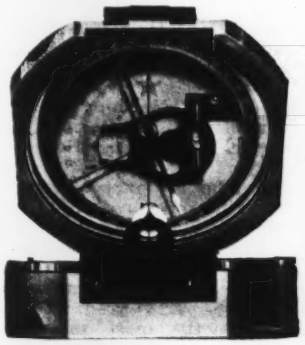


other part that do not require repair.

The oil is now drawn into the pump through an opening in the rear of the cylinder, then through an oil passage around the inner side of the cylinder. Placing the opening at the rear of the cylinders assures a positive flow of oil to the pump at all times, because of the tilted position of the hoist. The oil capacity of the new model is 16 quarts, whereas 20 quarts was required on the old model. The piston stroke has been increased 2 in., thus increasing the dumping angle approximately 5 deg. The twin cylinders reduce the average working pressure but make available increased lifting power for an emergency. The pump can develop 1,000 lb. per sq.in. of piston head area.

Improvements on Pocket Transit

The Brunton pocket transit, manufactured by William Ainsworth & Sons, Inc., Denver, Colo., has been improved by the addition of a second graduated arc on which the per cent grade may be read directly from the clinometer

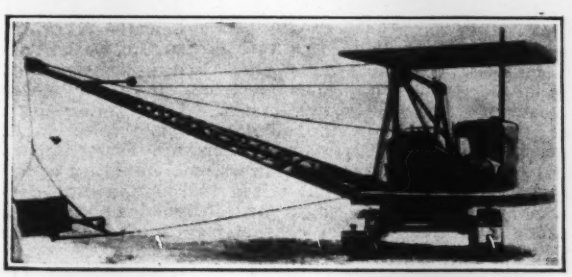


vernier. This, together with the improved sight apertures, enlarged hole in mirror with hair line and double level vials on the vernier, have added greatly to the utility of this instrument.

The case is of aluminum 2¾ in. x 2¾ in. x 1¼ in., weighing 8 oz., and while the instrument was designed primarily for use as a hand instrument, it may be used on a standard camera tripod for running long tangents and on a specially designed protractor as an alidade for plane table work.

Backfiller with Adjustable Boom and Full Circle Swing

The new backfiller just announced by the Buckeye Traction Ditcher Co., Findlay, Ohio, is built on the full-revolving principle. The full circle swing permits a working range that is large for this type of equipment.



The revolving base consists of a heavily ribbed solid electric steel casting, which provides a foundation for the power unit and the main machine assembly. The boom is of the standard lattice type construction, with a 10 x 12-in. section at the center. The full boom length is 29 ft. with an added 4-ft. box channel extension, which gives a maximum boom length of 33 ft. A unique feature of this unit is an 8-ft. removable center section which permits a short boom length of 21 ft. The elevation of the boom is controlled by power through a worm and gear mechanism.

Full length crawler traction is provided with cast steel treads 13 in. wide and a bearing area of approximately 15 sq.ft. Gearing is through independent clutches with automatic brakes controlled from the operator's platform. The road gage is 6 ft. outside tread. The motor is a 4-cylinder unit rated at 38 hp. at 1,200 r.p.m. A road speed of approximately 1¾ m.p.h. is developed.

For crane work the safe-load capacity is 3,000 lb. at a 15-ft. radius and 1,500 at 30-ft. radius. The all-steel filling and dumping scraper is 48 in. wide with cutters and rooters. The machine weighs approximately 17,700 lb., is 7 ft. 2 in. wide by 10 ft. long and has a height of 9 ft. 10 in.

Improvements on Light Weight Trench Excavator

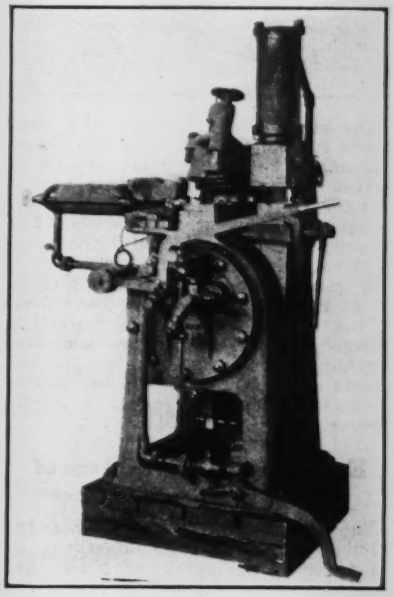
In 1921, the A. J. Penote Co. of Cleveland built a small wheel type trenching machine for its own use on a job in Detroit. A great many inquiries were received concerning the machine and it was decided to manufacture and sell it. This trencher was the prototype of the machine now manufactured by the Cleveland

Trencher Co., Cleveland, which has been improved in practically all details since the first machine was used.

The machine as now built is 17 ft. 2 in. in overall length and 4 ft. 9 in. in overall width. It is especially designed for digging ditches for gas mains, telephone and electric conduit subways, and for work in cramped places. Its cutting width varies from 10½ to 23 in. and a maximum cutting depth of 5½ ft. is possible. It has a traveling speed under its own power of 4 miles per hour. The power unit is a Hercules 27-hp. motor and the machine is equipped throughout with roller and ball bearings. Vanadium steel drive shafts and bronze gears incased and running in oil add to its general efficiency. Its light weight, 7,400 lb., and full tractor belt enable it to work on soft ground, lawns and cement sidewalks without damaging them.

New Drill Sharpener Occupies Small Floor Area

The compressed air drill sharpener that has just been added to the line of equipment manufactured by the Sullivan Machinery Co., Chicago, weighs



only 1,100 lb. and occupies a floor space of 22x26 in. The steel is clamped for upsetting by a vise operated by an air cylinder. It is upset by a horizontal hammer and dolly, and is swaged under dies impelled by a vertical hammer. A hand lever controls the vise and upsetting hammer, while a foot lever is used to control the vertical hammer. It is claimed that this machine is very economical of air, but that nevertheless the application of power for holding the steel in place and for operating the hammer cylinders that actuate the dies and dollys enables a perfect bit to be hammered out with equal effectiveness to that achieved in much larger and heavier machines.

Changes Made in New Model of Elevating Bucket Loader

The crawler loader, manufactured by the Link-Belt Co., Chicago, is being brought out in a new model incorporating several important changes. Formerly this loader operated on a swiveling principle, which made a feeder unnecessary as the digging end of the loader could be swung from side to side. The new loader utilizes a feeder and is not mounted on a swivel base. The buckets now have a plain face whereas they formerly were of a

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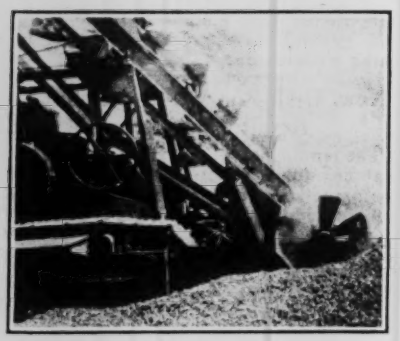
special digging type fitted with renewable teeth. The feeder consists of manganese steel paddles fastened to a hexagonal steel shaft. Feeder adjustment and collapsing mechanism for the loaders are both controlled by a hand wheel within reach of the operator.



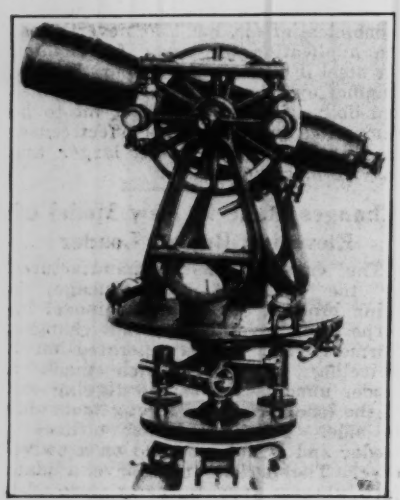
The chassis is practically the same except for the elimination of the swivel mechanism. A large steel casting is riveted to the chassis forming a support for the chassis and the connection to the front crawler shaft as well. The capacity remains practically the same at 1¾ cu.yd. per minute.

A gasoline engine power unit of 30 hp. at 1,200 r.p.m. is used. The speeds of the machine have been materially changed, the present truck transmission providing three speeds, 33 ft. per minute or 66 ft. per minute in the forward direction and 29 ft. per minute in reverse.

Ease in Handling Feature of New Precise Transit

The new precise transit known as the "Hell Gate" model, manufactured by W. & L. E. Gurley, Troy, N. Y., has been designed to supersede the large and cumbersome instruments which have often been used to secure a satisfactory result in secondary triangulation, precise traversing, and exact meridian determination. The new transit is very compact, making it easy to handle.

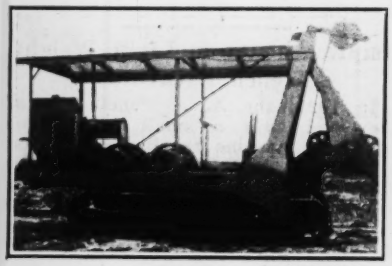
The optical features of the transit are especially noteworthy. Although the telescope has an overall length of only 12¾ in., the aperture of the objective lens is 1.93 in., the largest used on any Gurley instrument. This gives a resolving power of 4 sec. The measure of its light gathering capacity is said to be its ability to observe Polaris at noonday. The telescope is inverting and is regularly furnished with a magnification of 26x, or with an optional magnification of 15x. The change from one magnification to the other is easily accomplished by interchanging eye pieces.



Another feature is the new design of leveling head. It is of the familiar four-screw type but the leveling screws are larger and are individually fitted to bushings. A third feature is a new design of one-piece truss standard. This truss standard is of heavier cross-section than formerly. The reading of the horizontal and vertical limbs to 10 sec. and the sensitive reading of the level vials are especially noteworthy.

Excavator Improved by Use of Full Crawler Traction

A change in design of the 16B excavator manufactured by the Bay City Dredge Works, Bay City, Mich., includes the use of full crawler traction



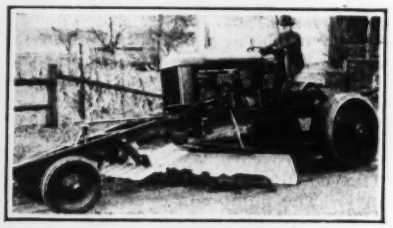
in place of crawler treads under only the front truck as heretofore used. With the exception of a slight increase in the size of clutches and bands, the other details of the machine remain practically the same. It is of all-steel construction and equipped for Alemite lubrication throughout. The new tread has a width of 16 in. and an overall length of 14½ ft. In turning the excavator, power is applied to both crawler treads.

Motor Grader Incorporates Many Refinements

The power delivered by the Fordson unit on the new motor grader of the Good Roads Machinery Co., Kennett Square, Pa., has been increased 400 per cent by gearing that reduces the speed from the usual 16 to 7 m.p.h.

Another outstanding advantage to this new piece of equipment is that the scarifier and scraper blade are controlled by power. All controls are located at the operator's hand. Hand adjustment is necessary to change the pitch of the scarifier or the cutting angle of the scraper blade, and also to extend the scraper blade to the right or left beyond its normal position. This lateral shift is 20 in. at a 60-deg. angle and 24 in. at a 90-deg. angle of the scraper blade.

The side members of the frame are 6-in. ship channels and all pedestal bearings are cast steel. The weight of the engine is concentrated over the blade and scarifier. Provision is made for cranking the engine at the right side of the machine. The wheel base is



12½ ft. and the overall length is 16 ft. 1 in. The blade is 7½ ft. long and a six-tooth scarifier is used. The weight of the machine with rubber tires is 8,650 lb., while the use of steel Fordson wheels reduces the weight to 6,500 lb.

Publications from the Construction Industry

Cold Weather Mortar — NATIONAL LIME ASSOCIATION, Washington, D. C., has published the results of recent tests by the Engineering Society of Wisconsin, performed at the University of Wisconsin, for the purpose of determining the kind of mortar best suited for construction during the cold weather. The booklet describes the different tests and conclusions reached. One part Portland cement, two parts lime and nine parts sand was considered to be the most satisfactory mix to withstand the effects of low temperature.

Paint—GOHEEN CORP., Newark, N. J., has issued Bulletin 103 for the convenience of those in charge of industrial construction and maintenance work. It gives specifications and standards for painting exterior and interior metal, hot surfaces, exterior and interior wood and concrete buildings, machinery and equipment. There is also included a chapter on the preservation of iron and steel and several pages of color cards.

Compressors — RIX COMPRESSED AIR & DRILL CO., San Francisco, Calif., has issued a catalog of repair parts for high pressure air and gas compressors, boosters, gas testing compressors and vacuum pumps. A cross-section of each machine is given with the different parts numbered and on the opposite page a price list.

Power Plant Equipment—WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., has issued a new 25-p. catalog on electrical drive for power plant auxiliaries. The catalog deals with the advantages and selection of electric drive for auxiliary pumps, fans and blowers, coal-handling equipment, pulverized fuel equipment. Several pages are included on the distinctive characteristics of the motors and the control systems used.